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Vol. xxii JULY, 1917 No. 7

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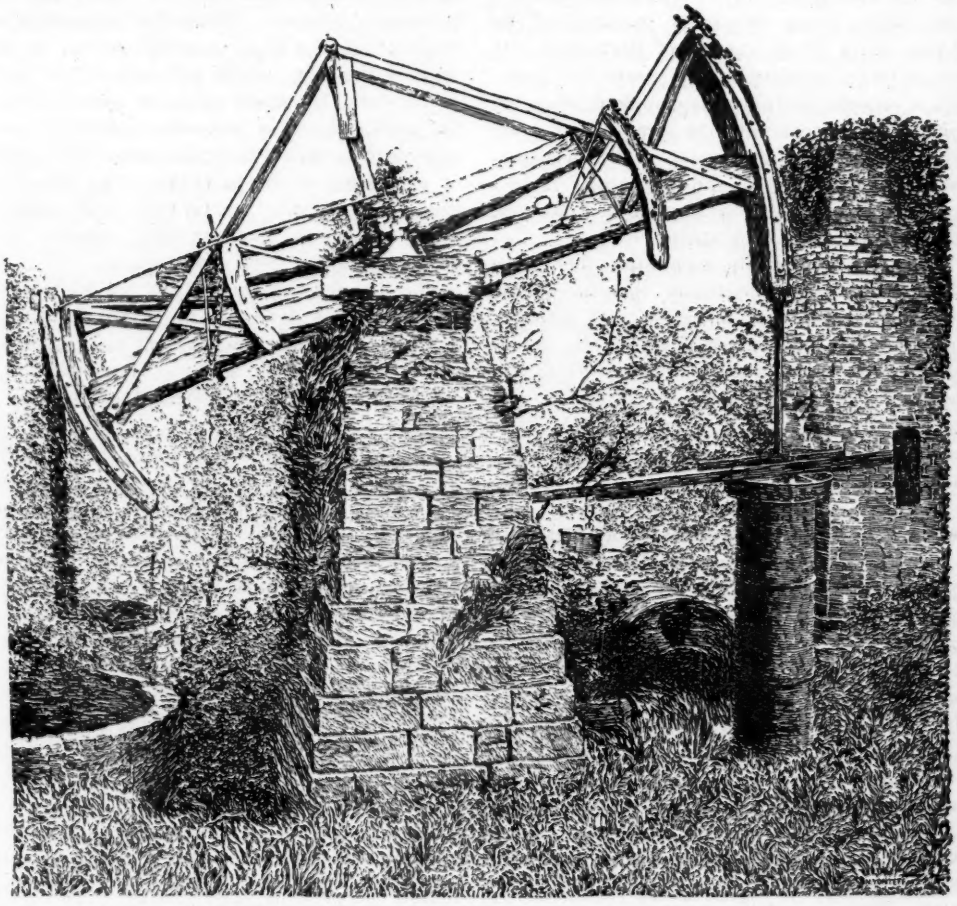
Vol. xxii. JULY, 1917 No. 7.



JAMES WATT'S OPPORTUNITY

AN ORIGINAL ATMOSPHERIC ENGINE

The cut above is from a photo supplied by Maurice Lees, Park Bridge, Ashton-under-Lyne, and recently published in The Engineer, London. It shows a relic of the early days of steam engineering still in existence as shown at Fairbottom, although it has been out of service nearly a hundred years. It is a Newcomen pumping engine, many of which found employment at the English coal mines.

In the view the steam cylinder is at the left and the pump at the right. It of course is not the pump cylinder which is seen, as that

is down in the mine and the pump works by direct lift. The steam cylinder is 26 or 28 in. diameter with a stroke of about 6 ft. The beam is of wood braced with iron and has segmental ends to which the steam piston and pump rods are attached by chains.

There was normally a slight preponderance of weight on the pump end of the beam, so that when steam at atmospheric pressure was admitted under the piston it would rise and the pump bucket would descend. When the piston reached the top the steam was shut off, the valves being originally manipulated by hand, and a jet of water was discharged into the cylinder condensing the steam and forming a vacuum, more or less complete, when the piston was forced down by atmospheric pressure thus lifting the water. The operation was necessarily slow and the waste of fuel enormous especially on account of reheating the cylinder after each strike.

Here, as was easily seen after the event, was the unique opportunity for the genius of Watt, whose first invention and probably his greatest, in connection with the steam engine, was the separate condenser. From this beginning the complete automatic engine was rapidly developed with results which have revolutionized the world more completely than all the wars.

A BELT RECORD WORTH PRESERVING

Among the exhibits at the Centennial Exposition of 1876 was a 60-in. double leather belt, 187 ft. long, shown by J. B. Hoyt & Co., of New York. This was the widest and largest leather belt that had ever been made, and was intended for the Augustine mills of the Jessup & Moore Paper Co., of Wilmington, Del., to whom it was delivered early in 1877.

This belt transmitted 650 to 700 hp., traveling over 24-ft. diameter pulley on the engine to a 9½-ft. pulley on the line-shaft, at an engine speed of 52 r.p.m., or a belt speed of 3920 ft. per minute, or 44.5 miles per hour. This mill operated continuously, starting at midnight Sunday and continuing in operation until midnight the following Saturday, so that the belt ran 24 hours per day, and averaged 300 days per year.

In 1902 the old belt had run 25 years, and in that time had traveled 8,010,000 miles, but its usefulness was by no means over. It always ran under damp conditions, because of its proximity to water, but notwithstanding these unfavorable conditions, when in 1902 it was sent to the factory to be cut into a 36-in. and other sizes, it was not rebuilt and there were no material repairs made upon it, and the same cement that was applied in 1876 is today holding the 36-in. belt together, and it has satisfactorily transmitted 350 h.p., equivalent to a working load of 198 lb. per sq. in. of sectional area plus tension, from 1902. It is still running 144 hours per week, with prospect of several years more of usefulness in its present position. When the time comes to replace it, it will be possible to cut it up into smaller belts, which will probably be used successfully for many years in places where the performance is less exacting in its requirements, and these again, when their days of usefulness in the particular duty assigned them is over, may be cut into still smaller belts, and so on, and the final remains will have a value for heels and washers.

The longevity of this belt is not due to the lightness of its load, for its maximum transmission of 700 hp. is equivalent to a working stress of 262 lb. per sq.in., plus its tension—no small load; nor has it been due to superior care.

This belt, now operating over a 16-ft. engine pulley at 82 r.p.m. to a 6-ft. pulley on the mainshaft, has a belt speed of 4122 r.p.m., equivalent to 46.8 miles per hour, and in its present position in 15 years it has traveled 5,256,576 miles, which added to the distance which it traveled as a part of the 60-in. belt, equals a total of more than 13,266,576 miles with a considerable addition to be made to these figures by its subsequent performance.

This belt, 187 ft. long, probably cost originally about $1250. There has been expended upon it practically nothing for repairs, and the cost of transmitting 650 to 700 hp. for 25 years, and 350 hp. for 15 years, to say nothing of the transmission by the smaller belts cut from the original belt, has cost $75 per annum for interest, and the amortization of the original cost will be completed at an annual cost of about $31, a total cost of about $106 per annum; or disregarding the service rendered by the smaller belts, and averaging the loads with the years of service of the 60- and 36-in. belts at 570 hp., this power has been transmitted at a cost of about 18c. per horsepower per annum.

WHAT THE INTERCOOLER CAN DO

BY FRANK RICHARDS

"I am in a kind of a mix-up about intercoolers upon two-stage air compressors, what they are for—although in a general way I suppose I know that—what they will do and what they will not do in the reduction of the intermediate air temperature, in the reduction of the volume of air entering the high pressure cylinder, and in the saving of power, but more especially I want to know about the extraction of the moisture in the air and the delivery of the air in a more or less dry condition so as to avoid all trouble at the drills or elsewhere from the freezing up, etc. If you will kindly do what you can toward informing me on these points, you will be rendering me a valuable service."

It occurs to me that there are others who are not altogether satisfied upon the points above suggested by my correspondent, so I am laying before the many readers of this publication, without further preface, my reply substantially as communicated to my friend.

FIRST THE SIMPLE AIR PROBLEM

Avoiding theories and formulas as much as possible, we will consider all through the case of an actual compressor, and one with which you happen to be in close touch, the air cylinders, 30 in. and 18 in. in diameter respectively and 27 in. stroke, running at 90 revs. per min., or a trifle over 400 ft. per min. piston speed, and delivering the air at 100 lb. gage. As you are somewhat up in the world and I do not know the altitude we will call it 5,000 ft., the normal atmospheric pressure being 12.14 per sq. in. absolute.

The volume of free air taken into the low pressure cylinder and passed along for delivery will be:

$30^2 \times .7854 \times 400 \div 144 = 1964$ cu. ft. per min. This is the full theoretical capacity of the cylinder, and a certain allowance must be made for the unavoidable clearance and piston leakage, also for the losses due to the leakage and unprecision of action of inlet and discharge valves. If we deduct 10 per cent. we then have

$$1964 - 197 = 1767 \text{ cu. ft. per min.}$$

which may be said to be better than the average performance of up-to-date compressors. But, whatever the clearance and leakage losses may be, the actual volume of air which passes the discharge valves of the low pressure cylinder, and is retained by them, must then go through the machine and be delivered into the compressed air system, subject of course to any other leakages that may occur. It seems absurd to have to say that the quantity of air thus passing the discharge valves cannot be increased or diminished by the presence of the intercooler. If it has ever been said that the volume of air delivered has been apparently increased through any changes in the intercooler it must be attributed to a general overhauling or tightening up of the machine when the change was made or to an increase of the speed of the compressor.

To ascertain the power saved by two-stage compression with efficient intercooling, we will first find what the power cost would be by single stage compression. We assume, then, that the entire work of compression is done adiabatically in the low pressure cylinder. With the free air intake pressure of 12.14 lb. abs. and the delivery pressure 100 lb. gage, the ratio of initial and terminal pressures will be $12.14 \div (100 + 12.14) = 1082$. With this ratio of pressures the ratio of volumes (Richards' Compressed Air Practice) will be .206.

Incidentally we may note the temperatures. With the above ascertained ratio of volumes the ratio of temperatures will be .5246. If the initial temperature of the air is, say, 70 deg. F. the terminal temperature will be $(70 + 461) = 531 \div 5246 = 1012$ deg. abs. or $1012 - 461 = 551$ deg. F. No matter how efficiently the cylinder and cylinder heads were water jacketed the discharge temperature of the air would not be below 500 deg. F. which alone gives us sufficient reason for avoiding single stage compression for such high delivery pressures.

Now as to the power required. The ratio of volumes being .206 the ratio of the terminal and the mean pressure will be .4458 and the absolute mean pressure will be $112.14 \times .4458 = 49.99$ and $49.99 - 12.14 = 37.85$ the actual working mean effective pressure. Then the power required will be $30^2 \times .7854 \times 37.85 \times 400 \div 33000 = 324.3$ H. P.

We are now ready to compare this result with that of two stage compression. With a reasonably efficient intercooler we may suppose

for convenience that the intake temperature is the same, say 70 deg. F., for both the low pressure and the high pressure cylinders, which might occur at certain seasons. It would be only necessary to have the cooling water at 50 deg. to secure this condition for the high pressure intake, and more than one builder of air compressors would be ready to guarantee this.

The diameters of the cylinders being respectively 30 in. and 18 in. the ratio of volumes will be $18^2 \div 30^2 = .36$, and as the intake air temperature is the same in both cylinders, the same ratio, inversely, will apply also to the pressures, and the intake pressure of the high pressure cylinder therefore will be $12.14 \div .36 = 33.72$ abs., or $33.72 - 12.14 = 21.58$ gage.

Here we encounter a curious condition and it must not be lost sight of in our computation. On account of the cooling effect of the intercooler, the volume of compressed air delivered by the low pressure cylinder is considerably larger than the volume of air, though at practically the same pressure, taken in stroke by stroke, by the high pressure cylinder, and it is upon the basis of this larger volume compressed and delivered that the power consumption of the low pressure cylinder must be computed.

The ratio of pressures being .36 the ratio of volume before and after adiabatic compression in the low pressure cylinder will be .484, and the ratio of mean pressure per stroke to terminal pressure will be .788. The mean pressure per stroke, then, will be $33.72 \times .788 = 26.57$ abs. or $26.57 - 12.14 = 14.43$.

For the power required for the low pressure cylinder we now have:

$30 \times .7854 \times 14.43 \times 400 \div 33000 = 123.64$

The intake pressure of the high pressure cylinder being 33.72 abs. and the delivery pressure 112.14 the ratio of pressures will be $33.72 \div 112.14 = .30$. Then the ratio of volumes (Richards' Compressed Air Practice) will be .425 and the ratio of mean to terminal pressure .7319. Then the mean effective pressure for stroke will be $112.14 \times .7319 = 82.08 - 33.72 = 48.36$.

The power required for the high pressure cylinder, therefore, will be $18^2 \times .7854 \times 48.36 \times 400 \div 33000 = 149.16$ h. p. and the total horse power for both cylinders $123.64 + 149.16 = 272.8$ h. p. which is 84 per cent. of the power we found to be required for single stage compression.

The computation above would have been much more complicated if all particulars and allowances had been included, and the actually possible saving of power, even theoretically, would have been somewhat less than now shown. In practice the actual saving of power may be said to seldom exceed 12 per cent. instead of the 16 per cent. which our computation here shows.

It is not to be too hastily concluded that the saving of power by the use of the intercooler as here shown is scarcely worth what it costs, especially for the temporary installations which compressed air plants so often are; for that is by no means the entire story. It is worth while to consider now the reduction of ultimate temperature effected as having an important bearing on the general problem.

In the low pressure cylinder we found the ratio of initial and terminal absolute pressure to be .36. Then the ratio of absolute temperatures would be .7438. The intake temperature being $70 + 461 = 531$ abs. the discharge temperature for the low pressure cylinder would be $531 \div .7438 = 714$ abs., and $714 - 461 = 253$ F.

The ratio of absolute pressures for the high pressure cylinder being .30 the ratio of temperature is .7055 and the initial temperature $70 + 461 = 531$ abs., being here assumed to be, by the action of the intercooler, the same as that of the low pressure cylinder. Then the terminal or delivery temperature for the high pressure cylinder will be $531 \div .7055 = 752$, and $752 - 461 = 291$ deg. F.

These delivery temperatures of 253 and 291 degs. F. are very different from the 551 deg. which we found to result from single stage compression to the same pressure. The former temperatures would not be sufficient to burn the lubricating oil used and cake or gum up the air valves, but with the latter temperature the case is very different, as many costly experiences have demonstrated. The reduction of temperatures here shown invariably accompanies the employment of any of the efficient intercoolers of the standard compressor builders, and no special intercooler can rightly claim any appreciable efficiency over any other in this respect.

THE WATER IN THE AIR

Another problem in connection with the employment of the intercooler is perhaps still more difficult, and that is its agency in eliminating the moisture in the air. The users of compressed air have been at times annoyed or more seriously inconvenienced by the presence of water in the air delivered, and the unceasing demand is for dry air. Now, there is no such thing as dry free air anywhere, and to call any air dry is only to say it is drier than some other air.

Water is carried by air in two different states or conditions. First—and this is the normal condition—it is mixed intimately with the air in the form of invisible vapor. Water in this form is in the air of the sky even when it is clearest and bluest, and it is also in the air which is taken into an air compressor no matter how dry we may think it. The ability of any body of air to thus carry water vapor is always absolutely and precisely limited, and is determined by its pressure and its temperature. There is always for any body of air a possible point of saturation, a possible combination of pressure and temperature, at which the air will just have all the water vapor it can carry, at which point the humidity of the air is said to be 100 per cent.

At this saturation point, if the pressure of the air is increased, that is if its volume is reduced, or if its temperature is reduced, either or both, the air will at once have more water vapor than it can carry, although the actual quantity of vapor present has not been increased in any way, and the excess of such vapor is immediately condensed or converted into actual water. The air thus, without any change in the actual quantity of water contained in it, at once becomes wet air. The water in excess by this change of air condition is not taken out of the air but remains distributed through it, consisting at first of minute globules which become more or less visible and cause an appearance of fog, mist or cloud.

The operation of changing the surplus of vapor into actual water, although the water is at first in a comminuted state, is essentially an act of condensation, and any intercooler which cools the air sufficiently to accomplish this may call itself a condenser or a condensing intercooler, one as much as another.

The water thus liberated ish eavier than the air in which it is contained and if the air could remain still, without change of pressure or temperature, the water would slowly settle down through it and gather on the bottom of the receiver or other vessel in which it might be contained. Also if the air in this condition were passed through a steam separator or similar device the water would wet and cling to the surfaces with which it might come in contact, slowly trickling down and thus be collected and drawn off. In any separator employed for this service, whether a detail of an intercooler or attached to it, only this water liberated in excess of the saturated quantity can be collected and drawn off.

The vapor carrying capacity of air may be said to be directly as its volume, or inversely as its absolute pressure, if the temperature is not changed. That is, if its volume be reduced one-half by compression, or, which is the same thing, if its absolute pressure be doubled, its vapor carrying capacity will be divided by two. On the other hand if the temperature of the air be increased, without change of volume or pressure, its vapor capacity will be doubled for about each 20 degrees of rise. In the operation of adiabatic air compression—and it is practically adiabatic in each cylinder of a two stage compressor the same as in a single stage machine—it will frequently if not generally occur that the changes in these two conditions of pressure and temperature will operate against and to an extent neutralize each other, because, in the act of compression, reduction of volume is accompanied by increase of temperature.

We are now ready to put the air through our air compressor, running under the conditions previously assumed and thinking now mostly of the water vapor in the air and what becomes of it. We assume that the humidity of the intake free air is 50 per cent. of saturation, or that the volume will have to be reduced one-half, or the absolute pressure doubled, before the 100 per cent. or saturation point is reached. We found in paragraph 12 that the ratio of the volume of air delivered by the low pressure cylinder was to the intake volume as .484:1, so that, as the volume was thus reduced to a little less than one-half, its vapor carrying capacity was a little less than the one-half required for complete saturation and, so far as the volume alone was

concerned, there would have been a slight release and condensation of the excess of vapor. This, however, was so slight as to be entirely negligible in view of the rise of temperature which occurred at the same time.

Remembering how rapidly the vapor capacity of air is increased by increase of temperature, it will be easily believed that a rise of temperature of only 5 deg. F. above the initial 70 deg. would have been sufficient to make up for the slight vapor carrying deficiency shown by the terminal volume.

As a matter of fact, we found, paragraph 17, that the delivery temperature of the low pressure cylinder was 253 deg. F., a rise of 183 deg. from the intake temperature of 70 deg. Remembering that the vapor carrying capacity of air is doubled with each rise of about 20 deg., and noticing how many such doublings are here, it is very evident, without going into figuring at all, that the air as compressed in the low pressure cylinder and delivered into the intercooler is exceedingly dry air, notwithstanding that it carries all the vapor that it had when first taken into the cylinder.

The air now enters the intercooler at the temperature of 253 deg. or probably a little less than that, for which the water-jacketing may be thanked, and is there cooled down to the high pressure cylinder intake temperature here assumed to be 70 deg. If the intercooler is disposed to put on airs or to make fine promises as to what it can do as a water extractor it will be well to remember that the air will not give up a drop of water until it is cooled to below the saturation point, and that then it will only give up the excess of water above the saturation point, and no matter how ingeniously contrived and labyrinthian may be the separator devises the air after leaving the intercooler and entering the high pressure cylinder must be at the saturation point, or, as we say, its humidity must be 100 per cent.

Since so small a portion at the latter end of the intercooler is all that can possibly have any effect as a water separator, it would seem to be more reasonable to make the separator a supplementary device through which the air might pass after the cooling of it was entirely completed and just before it entered the high pressure cylinder.

It is worth while to call attention to the amount of water in the form of vapor which is actually carried by the air in the case under consideration. At the assumed temperature of 70 deg. and 50 per cent. saturation the weight of water for 1,000 cu. ft. of atmospheric air is about 0.5 lb. Our compressor we found, paragraph 4, handles, say, 1,760 cu. ft. of free air per min. which, running continuously as compressors are apt to do, would be 2,534,400 cu. ft. per 24 hours, and the water carried through would thus be 1,267 lb., say 158 gallons, or 5 barrels, per day. How many days would it take an intercooler to drain out of this air one barrel of water? As far as my information goes, but this is not at all authoritative, it might take a week to get one barrel of water. This is just a hint of what practically can be done by the intercooler in eliminating the water carried by the air. It suggests how absurd must be the claim that any intercooler can have anything to do with guaranteeing the working dryness of the air after the final compression.

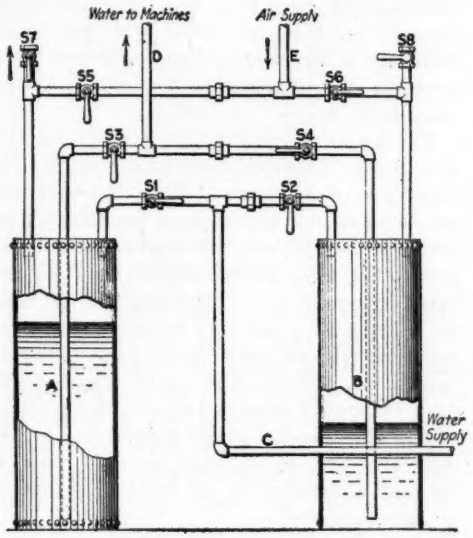
The air entering the high pressure cylinder necessarily at 100 per cent. humidity, or carrying all that it can of water vapor at the existing temperature and pressure, goes through the same experience as in the low pressure cylinder. That is, although in the act of compression its volume is reduced, its temperature is correspondingly increased, so that it is discharged from this cylinder also as very dry air, and only after its final and complete compression to the working pressure can the desired draining of the air be effected.

As the vapor carrying capacity of the air is greatest when its pressure is low and its temperature is high, so its vapor capacity is least when its pressure is high and its temperature is low and then it will readily release its water. These latter conditions naturally occur, or may easily be produced, after the final compression of the air is completed, and then the air may be so completely drained of its water that little or no trouble from that cause will be experienced by the ultimate users of the air.

If the compressed air is to be transmitted only a short distance there should be an efficient aftercooler very near the compressor, with a separator of sufficient capacity for the final drainage of the thoroughly cooled air before any of its pressure is lost. If the air is transmitted at its highest pressure a con-

siderable distance, say half a mile or more, through pipes of liberal capacity, so that the flow will not be too rapid, the air will be well cooled before it reaches its destination, and as it cools it will drop its water to flow along the bottom of the pipes, and if pockets are provided at the low points of the pipe the water will collect there and should be regularly drawn off.

When as the result of either of these arrangements the workers find that they are not troubled by water in the air, if they choose to go back and thank the intercooler for drying the air, when only half compressed, there would seem to be no way to prevent them from doing so.—*Power.*



TO SUPPLY WATER AT SAME PRESSURE AS THE AIR

BY H. H. HODGKINSON*

Water tanks arranged in the manner shown in the accompanying illustration are found to be of great assistance in driving drifts or tunnels where machines are used that require water passed through the drill steel. This method assures the drill runner of a steady supply of water having the same pressure as the compressed air. If the water pressure is greater than the air pressure, the cylinder of the machine soon becomes flooded. This reduces the speed of the drill and also washes all the lubricant out of the cylinder so that the drill finally stops. If the water pressure is lower than the air pressure, the sludge is not cleaned out of the drill hole properly. This not only cuts down the drilling speed, but may result in the loss of a drill steel from becoming stuck in the hole.

Delays in drifting are costly, but by the use of tanks arranged in this manner, it is never necessary for the drill runners to stop their drills for lack of water, it being only necessary to manipulate the four valves or stop-cocks on each tank. The drill runner is assured of good clean water without grit or dirt, which often causes a great deal of trouble, by plugging the water tube of the drill.

As the heading advances, pipe may be inserted between the tanks and the machines instead of moving the tanks each time. It is not necessary to remove the tanks when blasting the heading if they are placed at a safe distance.

The two tanks *A* and *B* are standard stock galvanized iron tanks made by any of the large drill manufacturers and have three holes in the top tapped for standard ¾-in. pipe fittings. Into these holes ¾-in. pipe is inserted, as shown, with the required unions, elbows, tees and eight ¾-in. stop-cocks. Stop-cocks are preferable to valves as they can be opened or closed more readily, show at a glance whether they are open or closed, because of the position of the handle, and are less expensive.

The operation of the tanks is as follows: Assuming tank *B* supplying water to the drills, stop-cocks S_2 and S_8 are closed while S_4 and S_6 are open, allowing water to pass through pipe *D* and air through pipe *E* respectively. In the meantime water is passing through pipe *C* into tank *A* and the stop-cocks S_1 and S_7 are open. S_7 is to allow the air to escape from the tank as the water flows into it through S_1. Stop-cocks S_5 and S_3 are closed. When tank *B* is empty S_6 and S_4 are closed while S_8 and S_2 are opened, which permits the water from *C* to fill it. By closing S_7 and S_1 and opening S_3 and S_5, tank *A* will now supply the water.

Two tanks are necessary; while one is supplying water the other is being filled. It is also necessary to have a supply of water to be piped to the tanks having a head of at least 5 ft., so that the water will flow into the tanks and overcome the friction of the connections.

*Mining engineer, care of United Verde Extension Mining Co., Jerome, Ariz.

GASES IN TRENCH WARFARE

A bulletin of the American Chemical Society says that the exact composition of the gases used in modern warfare is not known. It would seem that most commonly a mixture of chlorine and bromine is employed; possibly at times with the addition of sulphur fumes or formaldehyde gas. Chlorine and bromine are produced cheaply and in large amounts by the Germans as by-products of other industries. They are among the most active chemical agents known, attacking the eyes and the lining of the mouth, throat and nose. They first produce a hard cough, followed by the spitting of blood and finally asphyxiation, due to the destruction of the breathing apparatus. Only one part of chlorine or bromine in one thousand parts of air is necessary to produce almost instant death; one part in one hundred thousand, if endured for any length of time, is very dangerous.

For use in the trenches the gases are usually liquefied and stored in tanks from which the outflow is regulated by means of a valve. If the ground slopes a little toward the enemy and the wind is in the right direction, the gas, being heavier than air, flows over the ground filling the hollows like so much water. The most successful method for combating the gas attacks is by the use of a gas mask. The modification now employed is a hood, provided with a mica window, that fits down over the head like a bag, buttoning between the vest and shirt. When the first indications of an attack are evident, the hood is moistened with a solution of sodium hyposulphite (the photographer's "hypo") which combines with the gases, rendering them ineffective. Because of the large amount of gas required to poison the constantly changing air, an attack is only of a few minutes' duration. In case one is overcome by the gas, inhalation of dilute ammonia vapors will give great relief, since the ammonia combines with the gas in the bronchial tubes and relieves the difficulty of breathing, although it does not undo the injury already done. Because of the cruel suffering inflicted upon the enemy, the use of poisonous gases in projectiles was forsworn by the signers of the Hague declaration of 1899. The first gas attacks of the Germans took the enemy by surprise and inflicted great loses and an untold amount of suffering. Since then the masks have been so perfected that the troops have lost most of their fear of this ruthless form of battle—thus again emphasizing the fact that this is a war fought by science.

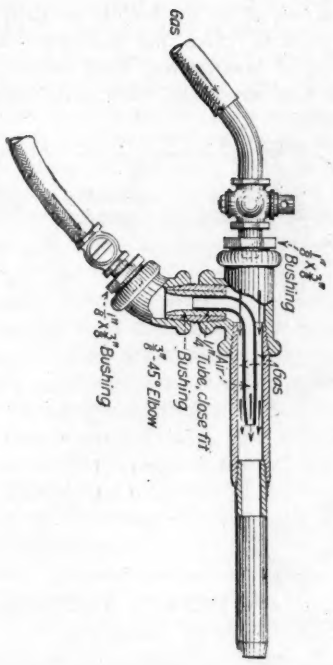
A GULF COAST OIL WORKS COMPRESSOR PLANT

One of the most modern and economical air plants ever installed in a coastal field is being installed for the Humble Oil Company on its Gaillard lease at Goose Creek by the firm of Tennant-Lovegrove Company, Inc., engineers. The plant will cost approximately $50,000 and the first two units will be put into operation on Saturday, May 19. The equipment is on the same basis with the equipment for a big electric light or power plant, economy and efficiency in the long run being considered first.

The boiler equipment consists of two 150-horsepower Franklin water tube boilers. The plant has seven Ingersoll-Rand Imperial type air compressors, each with a maximum compression capacity of 500 pounds per square inch. The total piston displacement for the seven compressors is 3,000 cubic feet per minute. The compressors are equipped with compound steam cylinders, which is an innovation in oil field practice, made necessary by the present high value of fuel oil. A "Booster" compressor, capable of 750 pounds per square inch pressure, is installed to take care of starting conditions or to handle an exceptionally deep well.

A steam pressure of 150 to 160 pounds will be carried. A 600-horsepower Hoppes Feed-Water heater has been installed which will deliver water to the boilers at a temperature of about 210 degrees F. Circulating cooling water for the compressor jackets is supplied from a set of Cameron pumps so interconnected that the plant will never be forced to shut down because of the disability of any one pump to work. A small electric lighting unit has been installed to take care of the power plant and field rig lighting.

The exhaust steam from the air plant will be used for oil cooking purposes, obviating the necessity of operating separate boilers for this purpose, and cutting down that large item of expense.—*Gulf Coast Oil News.*



GAS AND COMPRESSED AIR BLOWPIPE

The illustration shows a blowpipe for soldering, brazing, etc., made from pipe fittings. A copper or brass tube about ¼ in. diameter is filled with melted lead and given a right-angle bend so that it will go into a ⅜-in. tee as shown, after which the lead is melted out. A brass or fiber bushing is then driven into a ⅜-in. short nipple and drilled out to take the bent tube, which should make a close working fit, and the tube is driven into the bushing and the bushing screwed into the tee, the tube turning in the bushing while the nipple is being screwed in. A ⅜-in. nipple about three inches long is then screwed into the end of the tee over the air nozzle, and a ⅛x⅜-in. bushing is screwed into the other end. The air tube should be adjusted centrally in the ⅜x3-in. nipple. Valves or cocks are used to regulate the flow of air and gas.

The apparatus has been found to work best when the air flows through the bent tube as shown and the gas is led through the straight portion of the tee. Any size or shape of nozzle may be used, depending on the character of work to be heated.—*H. H. Parker in Power.*

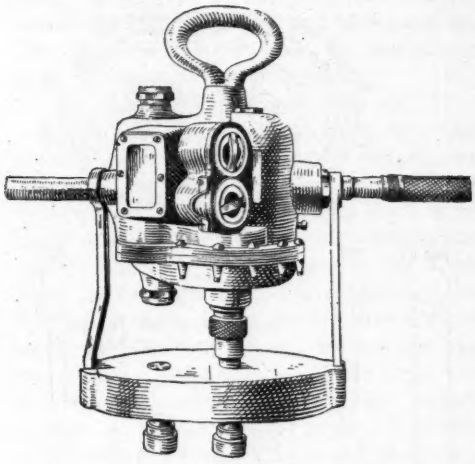


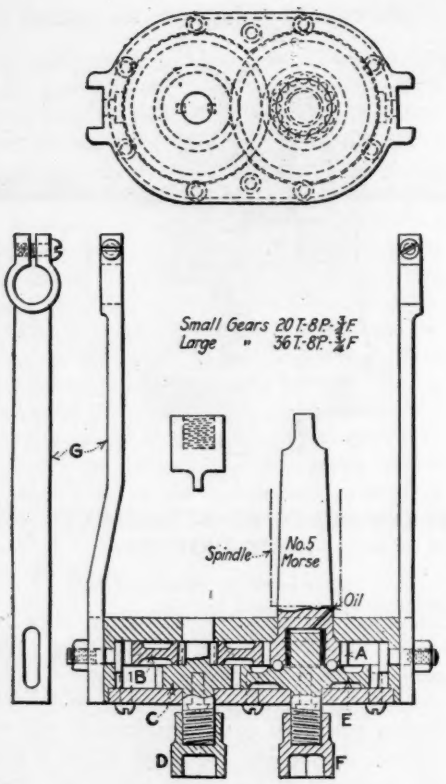
FIG. I

SPEED-REDUCING ATTACHMENT FOR AIR DRILLS

BY HARRY F. PANNEPACKER

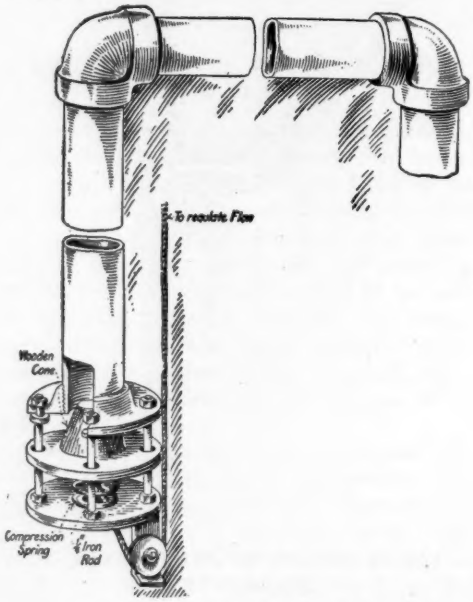
We had to tap over twenty-four hundred 1⅜-in. holes in special treated steel plates made into large structures, the shape of which allowed the use of air machines only. The drilling had been done satisfactorily, but the problem of tapping was still to be solved. The thickness of the plates was 5 in. Some holes were drilled $1^{7}/_{16}$ in. in diameter half the thickness, the remaining half being drilled 1⅜-in. tap size, while still other holes were simply drilled blind and tapped out 2½ in. deep. Tapping by air machine had heretofore been out of the question, as their speed, 225 r.p.m., equivalent to 81 ft. cutting speed on the diameter of a 1⅜-in. tap, was too high. The air pressure was 78 lb., and several trials proved most unsatisfactory. The speed-reducing attachment shown was then made and connected to the air drill. With it the spindle speed was reduced to 67.5 r.p.m., equaling 24.5 ft. cutting speed, and the results were satisfactory.

Previously, all tapping had been done by hand, a gang consisting of a leader and two helpers, whose capacity was 2½ holes per hour. With the speed reducer, from 15 to 20 holes per hour can be tapped, a distinct advantage being gained in the auxiliary spindle, which extracts the tap at increased speed. The machine is also used to insert the threaded rivets in the holes. As some of these have square



heads of the same size as the taps, this is an easy task. A number of the tap rivets have slotted heads, but a pair of special sockets with tongues drive them very nicely.

The machine, briefly described, consists of a milled flat steel body, 2¾ in. thick by 10¾ in. long, rounded at the ends and containing the four steel reducing gears. A No. 5 Morse shank, turned with the first pinion *A*, Fig. 2, of the train, meshes with the gear *B*. This second gear is keyed to a stud shaft that also carries a pinion *C* and socket *D*, from which is obtained the reversed direction. The gear *E* completes the train and drives the socket *F*. Ball bearings take the thrust. A brass plate screwed into position incloses the gears from the bottom, while extending studs of the two shafts act as receivers for attachment sockets for taps, etc., the main stud running in the right-hand direction and the auxiliary giving opposite direction at increased speed. A flat rod *G*, bolted to each end of the speed reducer and carried up to the handle on each side of the air drill, gives the necessary stiffness. The cost of making was soon covered by the gain in time saved and labor costs.—*American Machinist.*



TO KEEP THE SIPHON CHARGED

CONTROLLING A SIPHON

The objection is sometimes raised to the use of a siphon in draining pits, that it is difficult to regulate the flow so that when the pit is entirely drained the pipe will draw air, necessitating priming it again, and this continual priming might involve more labor than the direct use of a pump. Regulation of the flow of a siphon to any degree up to the capacity of the pipe can be secured by use of a valve made as here described or modified to suit any particular conditions met with in the various uses of a siphon.

The essential parts are shown in the illustration and consist of three flanges fitted to the discharge end of the siphon pipe, four rods, a compression spring, a cone-shaped piece of wood and a piece of rope. One flange is screwed to the end of the siphon pipe and connected to a second flange, by the four rods equally spaced. The cone-shaped piece of wood, which acts as the disk of a valve, seats on the third flange, which is guided by the

four rods and forced to its seat by the spring. The rope can be attached to the lower end of the wooden cone and is used to pull the disk away from the mouth of the pipe, thus regulating the flow of water. The spring at all times tends to return the disk to its seat. To make a better job the cone could be covered with rubber packing.

In operation, the longer leg of the siphon is filled with water and the other end placed in the pit that is to be drained. The rope is then pulled, and the water in flowing from the pipe will draw the water from the pit, the amount of water flowing being controlled by the valve opening. To stop the siphon, the rope is released allowing the disk to return to its seat, thus entrapping the water in the long leg, until it is desired to start the siphon again. This means is preferable to the common practice of throttling the intake.—*James M. Purcell in Power.*

SANDSTONE QUARRYING IN THE UNITED STATES

The above is the title of Bulletin 124, recently issued by the Bureau of Mines. Oliver Bowles, the author, also produced last year, "The Technology of Marble Quarrying." Both are admirable pieces of work, and of great value in their respective fields. The topics are thoroughly and concisely treated, the information presented is self evidently reliable and embodies gathered data. The 150 pages, 6 by 9 in., of the present issue are conscientiously filled with valuable matter, with excellent and pertinent illustrations and without a superfluous word. The matter following is abstracted from the above publication:

ROCK DRILLING IN SANDSTONE QUARRIES

The two chief types of modern drills for quarry work are the tripod or bar drill and the jackhamer. The former is a reciprocating drill mounted on a tripod or attached to a bar that is supported by four legs. When the tripod is employed it must be moved to a new position for each hole that is drilled. When a bar is used, however, a line of holes may be drilled, the drill being moved along the bar and clamped successively in new positions. Bar or tripod drills are usually operated by steam.

The jackhamer is a name given to a non-reciprocating drill operated without a tripod and provided with an automatic rotating device. It employs hollow steel bits, through which the exhaust passes and blows the cutting from the hole. It gives the best service when operated by compressed air.

ADVANTAGES OF COMPRESSED AIR

It has been found in most cases that compressed air affords certain advantages over steam for the operating of quarry machinery. Where steam is used in quarries there is usually a great deal of loss by condensation, and the variable temperature in the steam pipes makes it difficult to prevent leakage. As a result of these losses the effective pressure at the machine may be very much lower than the normal boiler pressure. When air is used the loss in pressure under similar circumstances is not nearly as great. Moreover, when drills are operated by steam, water must be supplied to the drill hole, in order to remove the cuttings. This arrangement requires extra labor and keeps the quarry floor wet or muddy. On the other hand, drills of the jackhamer type may be run dry.

If steam is used for drills, and the quarry is of wide extent, it is better to have a number of boilers close to points where drilling operations are conducted than to have a central boiler house and to conduct the steam a long distance through pipe lines. Where electric power is available a portable compressor is sometimes used. It is placed close to the drill, to which compressed air is supplied through wire-wound hose. [The last sentence evidently suggests the well known electric air drill.]

The time required to move drills from one position to another in drilling rows of holes is an important consideration, especially in thin-bedded quarries, where the holes are shallow and frequent moves are necessary. In this respect the jackhamer offers certain advantages, as it is held with the hands and no adjustment of supports is necessary. In general, a better time efficiency is obtained where jackhamers are used than where tripod drills are employed.

DRILL STEEL

The nature of the drill steel is an important consideration in sandstone quarrying, as the sand acts as an abrasive and the drill rapidly loses its gage. Narrow wings wear off rapidly, and consequently the drill steel should be shaped with a view of keeping as much steel as possible near the circumference. An-

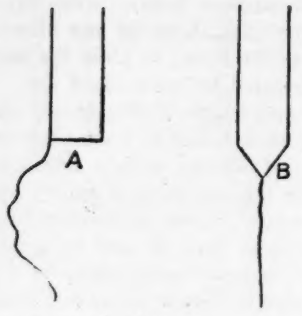


FIG. I

other important consideration is provision for adequate clearance. Most sandstone is cut rapidly, and in order that drills may give efficient service grooves of sufficent size should be provided to permit the cuttings to be removed without difficult.

Drill bushings are commonly hexagonal. It has been found by some quarrymen that square bushings are preferable, as the flat angles of a hexagonal shank wear off quickly. One company found by experience that where a hexagonal shank would last one month a square shank would last a year.

In finishing a drill hole one quarryman recommends the use of a pointed drill, in order to bring the hole to a point. This tends to promote straight splitting, for with a flat-bottomed hole the break may run off to one side, whereas with a pointed hole it inclines rather to run straight from the point, as is illustrated in Fig. 1.

RATE OF DRILLING

The rate of drilling is probably more variable in sandstone than in any other kind of rock, on account of the variable hardness. A rate recorded in northern Ohio sandstone is 38 seconds per foot for a 1¾-inch hole. In the quartzite near White Haven, Pa., holes of ½-inch diameter are drilled 3 inches deep in about 35 seconds. Thus, for holes of the same size this particular grade of Ohio sandstone is drilled about 45 times as fast as the quartzite.

THE "DITCHER" OR CIRCLE-CUTTING DRILL

In northern Ohio blocks for making grindstones are quarried in cubical form and the corners scabbled off and wasted. In certain southeastern Ohio quarries a more efficient method is employed for cutting out the circular stones. An air-driven drill of special type is employed to cut a circular trench in the quarry and thus produce blocks of the desired diameter at a single operation.

The "ditcher" is supported by tripod legs and by a vertical bar which fits into a square hole 4 by 4 inches in the rock surface. This hole is made quickly by drilling three parallel rows of three holes each with a small hammer drill, and by cutting out the intervening masses with a pick. The drilling machinery is attached to one end of a heavy crossbar, and a counterbalance weight is attached to the other end. It is rotated by a worm gear. The diameter of the circle to be cut may be varied by bolting the drill attachments in different holes on the bar. In cutting a 7-foot circle the steel is changed for about every 6 inches of depth, each successive drill being about ¼-inch smaller on account of the loss of gage by wear. A four-pointed, star-shaped drill head is employed. A sharp-pointed bar

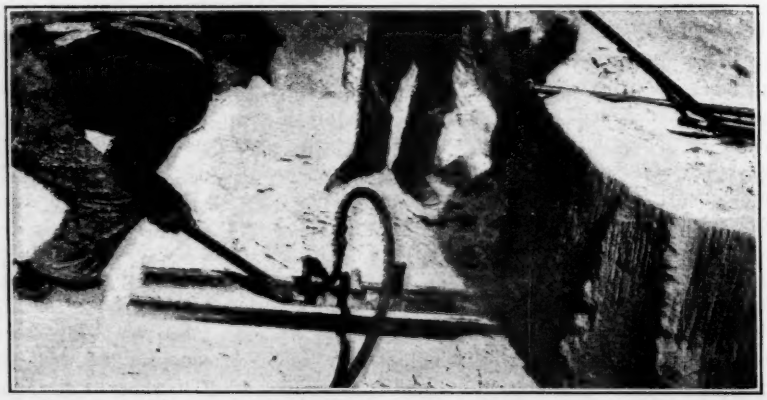


FIG. 2

is used to trim and straighten cuts where they meet other cuts. It is claimed that a "ditcher" will cut as many square feet per day as a channeling machine. It also takes much less time to set up, as no tracks are required.

By the method used in northern Ohio square blocks are quarried and then subsequently scabbled to a round shape, whereas by the "ditcher" method one operation is saved, as they are cut in circular form in the quarry. There is also a considerable saving of material by the "ditcher" method. When square blocks are scabbled the corners are entirely wasted, whereas by using the circle-cutting device small grindstones may be cut out of the corner pieces, and the waste thereby be greatly reduced.

The drill hole for making the floor break is made by means of an air drill which slides on a horizontal bed as illustrated in Fig. 2. The drill is kept in position by the operator by means of a hinged handle and crossbar.

SAND BLAST FOR CLEANING FORGINGS*

The importance of the sand blast as an efficient agent for cleaning forgings large or small is unquestioned. Sand blast machines as now perfected give effective results in regular practice, saving time, labor and expense.

THE SAND

Where sand is used for cleaning, it is naturally a matter of constant and primary expense, with quality of grit an important consideration. Sand should be sharp and clean, free from clay and other foreign substances which go to create dust and diminish the abrasive qualities, and with necessary hardness. Further, the sand should be thoroughly dry before being used, but not overheated to destroy its strength and cohesive qualities. A coarse beach sand seems to be in general use in many instances, with grains from 1/32 to 1/16 in. in diameter. Cape May grit as well is recognized as an effective sand-blast agent.

The efficiency of a sand-blasting process depends to a large degree upon the amount of usable sand remaining after the charge, and this has led to the perfection of apparatus for separating the used and good sand from dust and dirt. Moderate air pressures lend particular assistance in preserving the sand and its essential qualities for multiplied service.

SHOT BLASTING

Shot-blasting has taken the place of sand-blasting in many forge shops, and has not only proved superior in working qualities, but in economy as well. Ordinarily, shot of a diamond formed grit is used, consisting of crushed steel or chilled iron shot, angular in shape and with all, if not more, of the cutting qualities of sand, presenting a substantial resistance to impact. This shot varies in diameter from 1/40 to /60-in., being made in different sizes selected for use in accordance with the desired finish. Shot of this nature does not break up, and being much cleaner than sand, produces less dust. Moreover, it endures much longer, a small charge of from 150 to 200 pounds being capable of constant utility for an extended period.

Forgings are cleaned in this way in from 20 to 25 minutes, having the appearance of dull nickel plate when finished. Scoured down to the metal in this manner with entire elimination of scale, the cost of further machining naturally is considerably reduced.

THE NOZZLES

The arrangement of the sand spray or nozzle in sand-blast work is a matter of no small consequence, as its proper adjustment is not only a decided factor in the proper cleaning of the forgings, but in increased output, also relating directly to the air consumption. For entirely efficient operation, forgings ordinarily seem to require a direct medium high-pressure blast action with nozzles not more than six to eight inches distant.

Nozzles through which both the air and sand mixed are shot, varying in size up to ½-in. and larger, wear rapidly, due to the abrasive nature of the sand, and this becomes a matter for constant attention. The deterioration of nozzles should not be allowed to go too far, as the increase in air consumption through this impairing is likely to become exceedingly expensive, and also reduce materially the efficiency of the machine; nozzles where required should be replaced regularly. In some shops blast outlets will last only from two to three days, while in others, employing malleable iron nozzles, a correct orifice is retained for two, three or more weeks.

*Condensed from American Drop Forger.

AIR PRESSURES

Air pressures from 20 pounds up to 40, 60 and 80 pounds are found to give good results, the first noted being for aluminum and brass castings, the intermediate pressures for forgings and the like, and the last noted primarily for steel castings. In current practice, the average air pressure varies from about 40 to 80 pounds per square inch. Beyond these basic considerations, it is often maintained that the latter figure (80 pounds) is practically a minimum pressure for the satisfactory sand-blasting of different classes of forgings, and even still higher when available, as it will result in quicker and more economical work while, with but possibly a few minor exceptions, no possible injury to the material can ensue. In this, on the other hand, consideration must be given to the fact that the higher the air pressure, the quicker the sand is destroyed, but the actual work done depends decidedly upon the velocity of the blast.

Considerable modern equipment operating at less than 80 pounds per square inch is arranged with special motor-driven air compressors to eliminate the loss of power which is usually evidenced in utilizing any main air line installed for other plant service. This not only adds to the efficiency of the machine but reduces the cost of operation.

PRESSURE REDUCERS AND WASTE OF POWER

Allied with the subject of air pressure is that of the use of reducing valves on air lines. Loss in pressure reduction from high to low should be avoided, as after 15 or 16 pounds pressure the velocity rises very slowly. On this point one of the well-known makers of sand-blast apparatus gives a concrete example to illustrate the loss in the employment of reducing valves, as follows:

A ½-in. nozzle with air at 40 pounds gauge pressure discharges 196 cu. ft. of free air per minute, and to compress this volume of air at 40 pounds gauge pressure requires 24 horsepower. Should a reducing valve be employed on a line carrying 80 pounds pressure to reduce to 40 pounds, it would require 35 horsepower to compress 196 cu. ft. of free air, with the obvious result that the use of a reducing valve in this instance would mean a direct waste of 11 horsepower for each ½-in. nozzle.

SAND BLASTING OIL COATED FORGINGS

In the matter of heat-treated parts there is sometimes a question as to the action of the quenching oil in adhering to the material and interfering with rapid and efficient sand-blasting, due to the abrasive becoming saturated with oil or because it would seem likely to produce a sort of gummy surface, where the parts may have aged before being sand-blasted. Actual practice and results, however, indicate that this is not in any way a noticeable impediment to the speed of operation. Many cases may be found where heat-treated parts have been taken directly from the quenching bath covered with oil and subjected to the sand-blast, with the sand capable of use again and again during a period of from three to four hours.

HOW THE SAND BLAST PAYS

The sand-blast makes possible an average saving of 25 to 50 per cent. in tool upkeep and machinists' time; it not only speeds up production, but insures the delivery of a perfectly clean forging. Beyond this the appearance of the forging is improved, the defects are uncovered and the expense of useless machining is avoided. And all of this naturally infers a better price for the product. That the sand-blast machine is the best, quickest and most effective way to clean material of this nature is continually being demontsrated in actual practice in many forge shops.

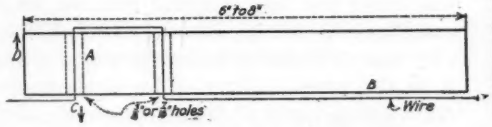
PROTECTING THE WORKMAN

The former dangers to workmen have been minimized by correct installations for dirt and dust removal. In recent years this subject has been given wide attention. Arrangements are now possible with different types of perfected control apparatus, to make constant change of air every two to five minutes or more to insure proper conditions in sand-blast rooms, as well as to provide for the efficient removal of dust and dirt, as sand-blasting at best is not the most desirable of shop operations.

Sand-blast helmets, gloves, goggles and similar apparatus also have been perfected to a fine point to make sand-blast work possible with proper operating environments, and eliminating unfavorable conditions existing in the earlier days. Respirators are available for use when adequate provision for exhausting dust from the room is wanting. Operators' hoods, as well, are in service, such being connected with a low-pressure air supply line to maintain them free from dust particles. That it is to an employer's advantage to adopt such

equipment is hardly to be mentioned in the case of the progressive shop, as it naturally brings far better and more beneficial service and results in the full accomplishment of maximum production, at the same time eliminating the dangers of unhealthy working quarters for the operator.

The selection of equipment is of particular importance for the proper scouring or cleaning of forgings. The right machine for the desired service is necessary for greatest efficiency, and careful consideration should be given to different types of machines and their qualifications to bring about an installation of advantage, profit, and utmost utility for the forging work and plant service to be accomplished.



HAMMER HANDLE FOR WIRE WINDING

TIGHT WIRE WINDING HOLDS THE HOSE ON THE FITTING

Some time ago the writer was employed in repairing riveting machines and their appurtenances for a gang of riveters on tank work. All the rivets were driven cold, the men were all paid by the piece and strike conditions prevailed. The wear and tear on equipment under these circumstances was very severe, but in no place was it more marked than in the way the fittings were constantly pulling out of the tail or buck hose. We are carrying 110 lb. air pressure on the lines. and this, coupled with rough handling, would pull out fittings some days faster than a man could put them in. All sorts of patent clamps were tried, but none proved equal to this job.

I was about to give up in disgust when one of the gang told me of a tool that solved the problem in the neatest way that I have ever seen during 15 years of construction work.

He took a hammer handle, sawed off a piece 6 to 8 in. long, then bored two 3/8 in. holes through it; the first 1/2 in. from the end of the handle, the other parallel and approximately 1 in. further up the handle, as shown in the sketch. He then pressed the end of a wire of about 16 gage through the holes, as shown below. The wire was pulled through hole A until 4 or 5 in. protruded. It was then clamped in the vise along with the fitting which had been previously forced into the hose, and the wire was then tightly wound over the hose, the tension being regulated by lightly holding the wire against the handle, with the hand at B. Having the wire and hose clamped in the vise, my man commenced to wind the wire down the length of the fitting as tight and close as ever a wire was wound on a spool; then back with three or four turns to the starting point, and there the two ends were twisted together with pliers in the ordinary manner, and the job is done to stay. It is hard to believe what an enormous pull can be exerted on that wire. In fact, the novice at his first attempt will probably pull his wire in two several times before he gets the correct notion of the pull he is exerting. But in no case will the fitting ever again pull out. In hundreds of cases I have never known a blow-out. Neither use, pressure nor abuse has any effect on a joint well made in this manner —the hose always wears out first, before the fitting gives trouble.

This work was all done on 3/4 in. and 1 in. hose, but there is no reason why it should not do for any size, or, in fact, in any place where it is desired to do a snug, tight job of winding wire. The convenience of the tool is further enhanced by the fact that it is cheap, can be made anywhere, any time, by anyone, and can always be depended on to do a tight, neat job.—*H. B. McDermid in Engineering and Contracting.*

LINCOLN HIGHWAY AND LINCOLN AIR WAY

Cross-country flying over the Lincoln Highway is expected to be the first result obtained in the movement of developing aeronautics in this country. Air craft abroad have been brought to a high state of efficiency in the past two years, and tremendous possibilities for them are promised by those in authority. Commenting on the situation Lieut-Col. George O. Squires, U. S. A., head of the aviation section of the army, says: "It occurs to me that since we have the Lincoln Highway laid out for automobiles, why couldn't we go along that same route and have reserve landings with gasoline and mechanics and 'first aid' in each of these reservations, so that one can start across the continent and have a Lincoln Airway over the Lincoln Highway?"

WIND POWER

BY W. H. BOOTH

Is it worth while to utilize the wind except for small country work? This is doubtful. A few years ago a modern type windmill was set up in London to generate electricity, a special throwover switch being employed between the driven dynamo and the electrical storage battery, so as only to utilize the mill's effort when this was equal to the required voltage. Experience has shown that even the makers of windmills are strangely ill-informed on the principles upon which they work and of the power they should generate.

If a wind blows at a velocity which shall be called 1, and a given mill performs 1 horse-power with that wind, why should it do eight times as much work with a wind of a velocity of 2? Many men will say that the work varies as the square of the velocity of the wind, but the true ratio is theoretically as the cube. To prove this let a time of one hour be taken. Then in the first case a length of one mile of air passes the mill in one hour. In the second case, the velocity being double, there will be two miles of wind passing. But the energy in a moving body varies with the square of the velocity. Each of the two-mile lengths of wind has 2 times the energy of a mile of one-mile wind. Therefore, 2^2 must be multiplied also by the weight of ratio passing in unit time, and the final power ratio is as $2^2 : 2^3$, or 8.

Rankine, who treated on windmills, was not very clear in his statement of efficiency, for he speaks of the cylinder of wind in which the mill revolves as though he had the full face of the mill in mind, and not merely that fraction of the face, usually 60 to 70 per cent. of its area, which is occupied by the sails. This fraction alone is acted upon by the wind. The actual energy in the wind per pound is represented by the expression, $E = v^2 \div 2g$ where $v =$ the wind velocity per second, and $g = 32.2$ or gravity, E, being in foot-pounds. The weight of air which comes into the calculation is about one-thirteenth of the area of the mill sails multiplied by the velocity of the wind and feet per second. The area of sail is of course the area on a flat surface, not the actual area of the inclined sail. Having found the theoretic form, not more than a fourth should be accepted as brake horse-power, and about half this as pump horse-power. A pump ought to do better than give a 50 per cent. efficiency, but experience of actual windmill pumps has demonstrated so much bad and inferior work that it is unsafe to count on more. To begin with, the pump rod gland is not apt to be liberally proportioned, and it must either leak or be too tightly screwed up, as to which more anon. Pump barrels are not always bored parallel, and a bucket without load on it and only about 4 ins. diameter has been known to grip its barrel so tightly as to require a pull of 140 lb. to move it. A windmill pump ought to have a solid grooved bucket of great length, so as to be frictionless. It must be larger than an ordinary pump bucket, because it has so short a stroke and so slow a movement, at times, that if not run long it would pass too much water by way of its water packed grooves. Very many windmills are made single-acting as to the pump. There is no harm in the single-acting pump if this is balanced. But very often it is not balanced, and herein lies the secret of the leaking gland. The mill cannot start the pump on a working stroke with a light wind. Once stopped, the mill can only start again when the wind blows strongly. So the gland is made to leak, and a light wind can tug at the bucket, and force water through the leaking gland until the barrel is empty, and away runs the mill merrily on the down stroke, and accumulates energy to help it up the up stroke. This is bad engineering, and single-acting pumps ought to be balanced by means of balance weights placed high, near the mill crank, unless the mill is one of those which drives by bevel wheels and a vertical shaft.

Too much should not be expected from a windmill, and for this reason the work should be balanced, and the machinery to be driven should be carefullly and accurately made in order to secure the best possible efficiency. Only thus can the best be got out of the mill, for with such care the mill will not only do better from the fair winds, but will utilize winds that would not move a poorly made mill or pump overdone by packing—developed friction.

The windmill as a very serious small power hardly deserves so much notice as above given to it, and is often used where it would be better to employ an electric motor. For small house water supplies the windmill will serve

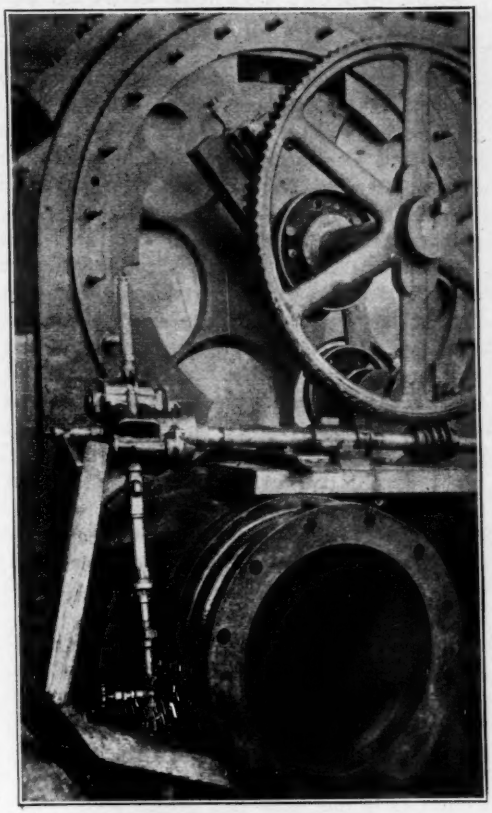
very well if arranged in conjunction with a large storage tank. Usually a windmill will work eight hours a day, but it may frequently happen that it will stand idle two or three days in succession, and the worse the mill is in respect of balance and workmanship the less it will do in light winds. As soon as a serious amount of work is demanded, the utmost caution should be exercised in deciding upon wind as the motive power. In a country house there should be at least a week's storage of water, for though it may be true that a mill will do an average of eight hours' work per day, some of this average is made up of sixteen-hour days, and there are very short days in between.

THE REVOLVING DOOR FOR THE SAND BLAST ROOM

Devices for the protection of the sand blast operator are continually developing, each having its special adaptation to certain conditions. The revolving door in familiar use for the entrances of public buildings has been found of value for placing work in the sand blast room and sucessively removing the same without interruption of operation. The quadrants of the floor formed by the angles of the wings are converted into shelves, revolving with the door, and upon these are placed the articles to be sandblasted. When the door is given a half turn and the articles are exposed within the chamber, blast jets play upon them directed by an operator outside the room on the other side, who looks in through a screened window.

CEMENT GUN SAVES A BIG CHIMNEY

An old octagonal brick chimney 125 ft. high and 12 ft. diameter, belonging to the Solway Process Company, Detroit, had become badly weathered so that large quantities of mortar had fallen out of the joints and much of the brick was eaten away to a depth of several inches. The exterior surface was first cleared by the removal of all loose material and then the entire structure was enclosed by triangular wire mesh furred out about 1 in. all around and upon this concrete was shot by cement guns forming a solid mass with a minimum thickness of 2 in. The air pressure employed was 50 lb. and the cost of the job about $1500.



A "LITTLE DAVID" DRILL BORES A BIG CYLINDER

The half tone above illustrates the facility with which pneumatic tools may be applied to various uses other than those for which they are normally employed. The photo comes to us from a gold mine in Canada and shows how a "Little David" pneumatic drill was connected up for driving a big boring bar. The air compressor cylinder which is being rebored is 38 inches in diameter. The drill spindle, it will be seen, is connected directly to the worm shaft, which gives it the necessary advantage in power and also produces the required slow rotation for the cutter head. It would seem to be quite unnecessary to say that the job was a complete success both mechanically and also in the saving of expense.

Japan built her first locomotive about two years ago, and now she is exporting locomotives. Recently she sent two to Saigon, Cochin China, for the French Railways there.

PARADOXICAL CARBON MONOXIDE

BY CHARLES S. PALMER

This is a story about one of the queer things that are continually happening in the limitless field of chemical discovery; for, if the dear public only knew it, there is more of the novel and sensational in the good Journals of the American Chemical Society, than there is in the last war bulletin or the last "thriller" of the best-selling novel.

This story has to do with what the chemist calls "carbon-monoxide," for short. This carbon-monoxide is a very common substance, and a weird chemical paradox. It is a colorless gas, without any decided taste or odor, but with an inherent antipathy toward human life; that is one side of its character. The other side is that it is probably a common go-between in that wonderful alchemy, whereby the green chlorophyl umbrella of green leaves, and the sunlight, play their continual duet of reducing the carbonic acid of the air, to the sugar-like substances on which animal life of the globe depends. And that is quite enough of a proposition for one small substance to tackle.

Now, in a way, we are familiar with this witch, carbon-monoxide. It is the stuff which burns with that beautiful blue-green, or green-blue flame in the bottom of the humble candle flame. It is the same stuff which shows the almost colorless flame when fresh coal is added to a fire. It shows well in the common gas range, with the same blue-green flame.

We are also very familiar with the same gas, when it furnishes our papers with the laconic note that Mr. So-and-so committed suicide by "turning on the gas" and forgetting to turn it off. For this carbon-monoxide is a large part of common city gas, especially when it is what is called "water-gas"; and this water-gas would work deadly havoc with civilized humanity were it not for the fact that to get common gas to give light as well as heat, it is customary to "carburet" the gas with some cheap oil; and as this cheap carburetting gas is itself bad smelling, and gives common city gas most of its bad ordor, it also serves to warn careless humanity when "the gas is leaking." And so it comes about that water-gas, though very poisonous, on account of the large quantity of this same carbon-monoxide gas, actually poisons very few people, because the dangerous leak is so well and promptly advertised by the bad smelling carburetting gas. Thus we are, albeit unconsciously, very closely associated with the heroine of this story, the tantalizing carbon monoxide.

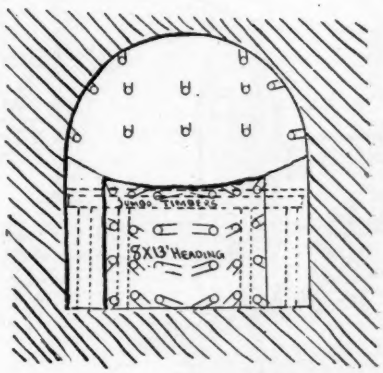
But now the strange part of this narrative comes in. If this carbon-monoxide gas is so common in such common processes as the burning of coal on the one hand, and in the reduction of carbonic acid gas on the other hand, why does it not accumulate in some corner of Mother Nature's laboratory? Why should we not find it in convenient hiding in a thousand places? Why should we not run across it every now and then—not in the animal world, for it is really poisonous to most animals, perhaps to all—why should we not find it at least quite common in some nook of the vegetable world For the fact is, and we have told it by our series of queries—the fact is that this carbon-monoxide gas has not been commonly found in the vegetable world. And that is all the more strange, because the air food of most green plants must go through a stage where it is something very much like carbon-monoxide. Perhaps the real reason is that we do not yet know that this witch, carbon-monoxide, is not very common in plants, green plants particularly. And back of that statement is another which one might make with a large degree of safety. Perhaps it is not known to be common because it has not been looked for. For it is a curious fact in chemical progress, that there are lots of things which are not found till they *are* looked for, in the hide-and-seek of inventive carelessness. A similar thing was true of the finding of argon and its attendant throng of inactive elements in common air. Though the first facts which, if followed up might have told our great-great grandfathers, were known, yet they were not followed up, till another set of facts forced the issue—and so argon and her attendants came out into the open. A somewhat similar thing was true of that sensational element, radium; though, when it was once well guessed at, it still took many months of fractioning out to get even a microscopic sample of the most revolutionary element of all—radium. But this is not the story of radium.

The finding out of one hinding place of carbon-monoxide came about in a curious way. We do not need to be told that one result of the war has been a marked scarcity of potash

compounds in all countries, except Germany, which has vast stores of potash in connection with her salt mines. Now, it was a side hunt for potash which brought out the knowledge of one lurking place of carbon-monoxide. Among the many places where our chemists looked for potash compounds, was in the ashes of sea-weeds; and it was in one of these floating vegetable unused wastes that a most interesting discovery was made. It came about in this way:

In getting out a report on the possibility of the economic extraction of potash salts from sea-weeds, a careful survey was made of the chemical composition of all parts of the large "kelp" sea-weeds of the California coast. And, further, in this chemical survey, it was noticed that some of the kelp plants contained large quantities of a mixed gas. Now in the analysis of this gas from one kind of gigantic kelp on the California, or rather, on the Washington coast—a brown alga, which modestly tolerates the name *Nereocystis luetkeana,* this carbon-monoxide was found. This kind of kelp is said to grow with stipe, or stem, or stalk of from fifty to eighty feet in length. These stalks are hollow, from the bulb-like top, to the "hold-fast" at the bottom. "The walls of the stipe are from a quarter to three-quarters of an inch in thickness, and are lined on the inside with a delicate web-like structure which is relatively quite dry. This hollow space, in large specimens, has a capacity of from three to four liters"—that is several quarts. "The gas is almost always under less than atmospheric pressure." There it is, the hiding place, or one of them, of this chemical dryad of the vegetable world—the air spaces of the stems of this giant seaweed of the Pacific coast.

Now this gas from this corky stem substance of this kelp had been analysed before; and oxygen, nitrogen and carbon-dioxide had been reported; but not carbon-monoxide—till one Seth C. Langdon of the State University of Washington at Seattle, noted something irregular about the method and results of the analysis of the gas. Then, on making a careful and complete analysis, Professor Langdon found that this same poisonous gas—poisonous to animals—was contained in this sea-weed gas in quantities from one to twelve per cent. And this is no small quantity, for it was enough, not only to show all the chemical tests, but it was enough to kill canaries, chickens and guinea pigs, when placed in the gas. Of course the gas was drawn off from the sea-wood in large quantities; and its identification is beyond dispute. Professor Langdon has placed the whole world of both chemists and curiosity hunters under lasting indebtedness for his novel and surprising, and yet wholly natural, discovery. It is gratifying to know that Mother Nature does not only use and make, but also that she actually stores up, notable quantities of this paradoxical gas, carbon-monoxide. This is said to be the first time that such an occurrence has been noted for the vegetable world; and yet, most of us might say: "Well, why not?" Of course, but all the same, it is a decided step in "The Advancement of Learning."—*Scientific American.*



LAYOUT OF DRILL HOLES

TUNNEL DRIVEN WITH BOTTOM HEADING

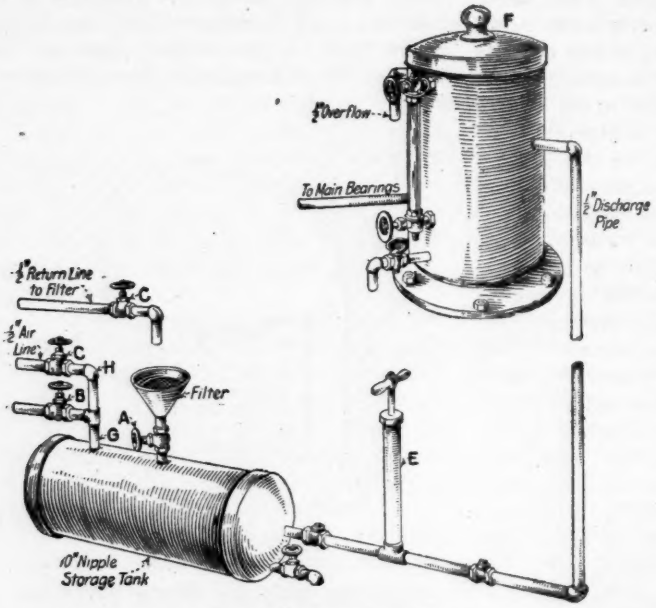
About 5000 ft. of the Mill Creek, Missouri, sewer tunnel, was driven through solid limestone rock by the James E. McMahon Construction Co., St. Louis, who used the bottom heading method and secured an average progress nearly twice as great as that attained by two other contractors who used the top heading method on other sections of the same tunnel under similar conditions.

The 8x13-ft. heading was drilled with 22 to 24 holes from 7 to 9 ft. deep loaded with 60 per cent. dynamite detonated with No. 6 caps and giving an average break of 4½ ft. per shock. Four or five shots were fired in two 10-hr. shifts, requiring about 4lb. of dyna-

mite per yard for the heading and about ½ lb. per yard for the breakdown and wings.

The average progress of the heading was 16 ft. in 24 hr. and the best record was 114 ft. in one week.

Jumbo timbers were set up in the bottom heading to receive the rock from the top heading which was broken down with twelve holes and the material dumped through holes in the jumbo platform into muck cars on the floor of the bottom heading. By this system work on the breakdown and wings was carried on simultaneously with the bottom heading.—*Contracting.*



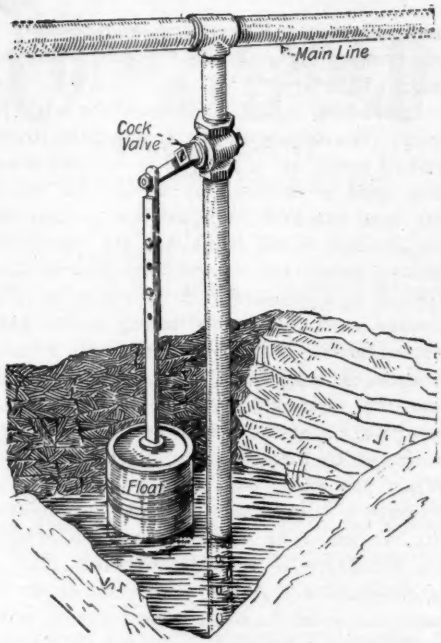
HANDLING OIL BY COMPRESSED AIR

The sketch shows a convenience that I applied to an engine recently, which may prove valuable to others. This engine was not provided with means for returning the lubricating oil to the overhead tank. We first made a filter tank, using a 10-in. nipple 24 in. long and two caps; holes were drilled and tapped for the pipes as shown. Having a branch of the factory compressed-air system in the engine room, we piped it to the tank at *G*, so that when the tank *F* is becoming empty and the filter tank is filling up, all that we have to do is to close the valves *A* and *B* and open the air valve *C*. In about ten seconds the oil is transferred from the lower to the upper tank. Then, by closing the valve *C* and opening *A* and *B*, the lower tank fills again. A hand-pump *E* was put in the discharge line for use in case the air supply should fail. If the facilities for making the hand pump are not available, a tee may be fitted at *H*, to which an ordinary automobile tire pump can be connected.—*William Hays, Indianapolis, in Power.*

CHLORINE AND TYPHOID

It is positively amazing that only two or three pounds of liquid chlorine, costing about 16 ct. a pound, will kill all the typhoid germs in a million gallons, or more than eight million pounds of water. Picture to yourself a pint of liquid chlorine and a reservoir of water 8 ft. deep, 20 ft. wide and 400 ft. long, containing 4,000,000 lb. of water. Pour this pint of chlorine into this great tank of water and mix it up. You will be unable to see, taste or smell the chlorine thus diluted, but every typhoid germ will forthwith "curl up and die." Talk about homeopathic dosing! The ghost of Dr. Hahnemann must turn green with envy every time the valve of a chlorinator opens to vent its tiny droppings. Think of it! One drop of chlorine in two barrels of water puts Mr. Microbe permanently to sleep.

Every year 300,000 Americans are incapacitated by typhoid and 20,000 of them die. Bring these figures home to yourself. Imagine every citizen of Seattle, or of Indianapolis, being compelled to suffer for weeks every year from this terrible disease; and then, in your imagination, follow 20,000 hearses to the grave. What you thus imagine is the numerical equivalent of what actually happens every year. And it is a preventable happening, preventable at a cost so low that nothing but gross ignorance accounts for our failure to act. Resolve to do your part to eliminate this ignorance and its consequent suffering.—*Engineering and Contracting.*



AN AUTOMATIC SUCTION CONTROL

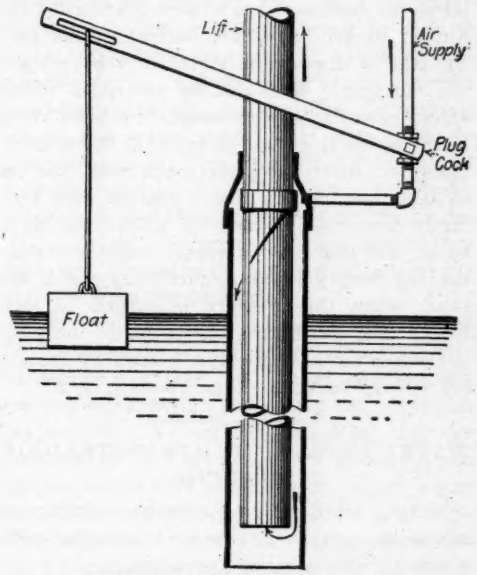
At some mines where several pumps are required, each drawing water from several sumps, unless some kind of automatic suction-control device is employed more than one pumpman will be necessary to keep all the pumps in efficient operation.

The accompanying illustration from *Coal Age* shows a device useful for governing the flow of water from the various sumps to a single pump. It consists essentially of a cock in the sump suction line, a float in the sump and a suitable rod and lever connecting the two. When the water in the sump rises, the float opens the cock; when it falls, it closes it.

For a float an old powder can may be used. The hole, of course, is first effectually sealed after which the can is given a good coat of paint. This answers the purpose fairly satisfactorily. By means of the above-described apparatus several sumps may be kept pumped out without the continuous care of the pumpman.

HUMIDIFYING THE OVEN ATMOSPHERE

H. H. Dunn, industrial engineer of the Roanoke (Va.) Gas Light Company, recently undertook the devising of gas equipment to melt butter on turn-over buttered rolls without making them crusty. He started off with confidence as the task seemed simple, but found the problem more difficult to solve than it seemed. Aften ten days of effort he solved it by installing one-hole hot plate on which was placed a small single Elgin oven in which the rolls are placed to melt the butter properly. On top of this oven he placed a number 20 Ideal Steam Cooker with wire shelves. With a small amount of water in the pan, the heat from the oven in which the rolls are placed to melt the butter just gives the proper amount of moisture by being placed on top of the Elgin oven and keeps the rolls from becoming cold or soggy.—*Am. Gas Eng. Journal.*



AIR LIFT FOR SLIME PULP

BY A. W. ALLEN

The accompanying diagram illustrates a type of air lift installed recently in South America for the first stage of a compound lift to handle slimed-ore pulp. The second lift was of the ordinary type with compressed air delivered into the bottom of the lift in the usual way. A comparison was therefore possible as conditions were equal, and results obtained were all in favor of the type illustrated. The dimension of the lift pipe was 3½ in. and of the air pipe, 5 in. The 5-in. pipe was carried just above the level of the pulp and was connected with the lift pipe by a 5x3½-in. reducer. It extended about 2 in. below the level of the lift pipe —*Power.*

AIR JET CLEANS PIPE PILES ON PHILADELPHIA SUBWAY

A three-inch jet nozzled down to 2 in. is being used under 100 lb. pressure to clean out sand and gravel from the pipe piles being driven in Philadelphia to support the walls of the City Hall station of the new subway. The piles being filled with water, the jet acts as an air lift, blowing the sand and gravel out of the top of the pile with considerable velocity into the underpinning pit. While one pile is being cleaned, it is necessary to cap the others driven in the same section to prevent filling them. The piles, which average 18 or 19 ft. penetration, are driven several feet at a time and then cleaned out with the jet to the bottom. Care is taken not to allow the air jet to get below the bottom of the pile, for fear of drawing in material from beneath the building. With one or two piles which stuck, however, it was possible to start them again by cleaning out 6 or 8 in. below their bottoms. After the piles reach rock, the jet is again put in and cleans out the pipe perfectly, removing everything except the hard rock. The jets are not worked into the material, but simply lowered until they touch the sand, when the pressure is turned on full force. The dirt that is blown out of the piles is cleaned out of the wall pits later by shoveling it into buckets.—*Eng. News-Record.*

WATER PRESSED BY AIR INSTEAD OF PUMPING

Having on hand two sheet-steel tanks of 29,000-gal. capacity and an air compressor with plenty of off-peak time, the designers of the Lawrenceville, Ill., filter plant were enabled to eliminate the purchase of a wash-water pump, the compressor being available to store up sufficient air under pressure on top of the water to wash the filters.

The plant, which has only recently been put into operation, consists of two rapid filters of 180 sq. ft. filtering area each, with the usual system of strainers fitted for washing at a rate of 2 ft. vertical rise per minute, with water only. The two long horizontal tanks alongside the filter building were formerly used on the distribution system as storage tanks and pressure equalizers. The engineers considered it advisable to use these tanks since they were available, rather than to scrap them and purchase a large pump and possibly an air blower, both of which would stand idle much of the time.

In washing a filter the procedure is as follows: Starting with the tanks three-fourths full of water, air is pumped in through a 2-in. line until a pressure of 25 lb. per sq. in. has been attained. The air line is then shut off adjacent to the tanks, and the compressor fills an air-storage reservoir of 340 cu. ft. of free air to a pressure of 80 lb. per sq. in. This storage is on the air line leading to the wash-water tanks. When the required pressure is attained and the storage opened into the line, the filter wash is started. By proper manipulation of the wash-water valve an even wash can be maintained at the required rate. When the filter has been washed, the air pressure is released and the tanks refilled from city service. The only objection reported to the procedure is that the operator may be careless and not give proper attention to the manipulation of the wash-water valve, in which event it is possible to blow up the sand bed.—*Eng. News-Record.*

SCIENTIFIC DEDUCTION OUTSTRIPS IMAGINATION.

In the *Journal* of the British Astronomical Association for November, 1916, Mr. Edwin Holmes criticises the following statement of another member of that Association: "A planet in such a condition" (as Jupiter) "must *necessarily* have a dense and deep atmosphere."

After referring to an investigation by Mr. E. W. Maunder of the circumstances which settle the heights of planetary atmospheres, Mr. Holmes says: "We must not forget that on Jupiter gravity doubles the pressure (or halves it) every 1.6 miles. M. Flammarion calculated that if his atmosphere had a depth of only 100 kilometers, or about 63 miles, the density at 37 miles from the surface would be the density of platinum, 'and yet there are 25 more doublings of density in the remaining descent.' He adds: 'It is perfectly monstrous.' The atmosphere at the surface would be 17 millions of times more dense than platinum. I think this amounts to telling us that long before we reached even 37 miles down, the atmosphere would be compressed into a solid body and would be in no reasonable sense an atmosphere at all.

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UNNECESSARILY VULNERABLE

The state of actual war which now exists, with a foe alert, resourceful and unscrupulous, has set us to studying our defensive weaknesses, and to devising schemes for our safeguarding against the too evident possibilities of disaster. It is not easy to compute the derangement which might be caused by a single fortunate (?) hit by a shell of high explosives from a long range gun, or by a single charge of dynamite judiciously placed by traitor or spy.

New York City, for instance, or let us say Manhattan, has practically no sources of potable water within its limits, and if the continuous inflow should be stopped what could become of its crowded millions? No hasty surrender to any foe could avail to save it from incalculable horrors. It has been impossible for us not to think of the terrible consequences which would follow the cutting off of our water supply, and very properly arrangements have been made for policing and guarding watersheds, reservoirs, aqueducts, gatehouses and the distributing system in detail. We are fortunate in being able to believe that the perfectly possible catastrophe is very far from the probable.

While apparently everybody has thought of the possible danger of water stoppage, why has there not been an equally prompt and general apprehension concerning our municipal gas supply? We are not suggesting that the stoppage of our gas would be a catastrophe commensurate with the stoppage of our water supply, but still it would be sufficiently serious. Illuminating gas we have been in the habit of calling it, and such it still is, but its now most indispensable function would be much more correctly characterized today by calling it cooking gas. Not only is three-quarters of our domestic cooking done by gas but we have no available substitute. Stoves have generally disappeared in flats and apartments and we have neither the fuel nor the means of burning it. We couldn't boil an egg or make a cup of tea, to say nothing of frying, broiling, roasting or baking, and who could live without these necessary services?

And then it is so easy to knock out the gas service. Our district gas holders are the most conspicuous objects from a distance and ideal targets for long range gunners, a single hit in every case sufficing for their complete in-

capacitation, whether from a gun or from a hand placed bomb.

We do not take to ourselves any reprehension for calling attention to this matter and thus suggesting possibilities of mischief, because the opportunity is too self-evident to have been lost sight of by those who are looking for chances to make trouble. We may in fact do good rather than harm by calling attention to a danger to be guarded against.

But the aggravating thing is that this danger is one absolutely unnecessary to be incurred. The gas holders and the system which employs them are wrong throughout both in peace and war, and should for many reasons be discarded.

As natural gas is distributed at pressures which make the local gas holder impossible, there is no reason why "manufactured" gas cannot also be distributed in the same way. There is no imperative reason for the gas holder except for storage at the gas works, and even there it might be down in the ground instead of up in the sky. The flow service could be maintained by compressors and, as has been amply demonstrated, gas served at higher pressures would give more satisfactory results.

SCARCITY OF COMMON SENSE

The second edition of the work on Compressed Air by Professor Elmo G. Harris, of which we desire to speak only in terms of high commendation, reproduces the preface to the first edition in which occurs the following, to us, amazing paragraph:

"As one advocating the increased application of compressed air and the more efficient use where at present applied, the author has prepared this volume for college-bred men, believing that such only, and only the best of such, should be entrusted with the designing of compressed air installations."

In reply to this we have no word of deprecation for college-bred men, but we do protest that they are no more absolutely requisite for compressed air installations than for steam installations, for electric installations, for water pumping installations, for railroading installations or anything else.

We are quite willing to say that for all such installations a greater prerequisite than college training is mechanical common-sense, engineering common sense, or just common, every day common sense.

As narrated in a recent issue of the *New York Herald*, a young man went to England at the beginning of the war and entered the Royal British Flying Corps. A year ago he was flying at the front carrying important messages to London and return, having developed into a most skilled air pilot. Returning to this country he was recently rejected from our aviation service because he had not the college qualification. Another case where common sense seemed to be out of service.

THE MARIETTA COMPRESSED AIR PROCESS FOR OIL WELLS

The Smith-Dunn or Marietta process for increasing the production of wells in an old field by forcing air down one well among a group was discussed by J. O. Lewis of the U. S. Bureau of Mines at a recent meeting of the Petroleum Club of the University of California. This method was developed at Marietta, Ohio, and is now used extensively in the Appalachian fields and also in some of the Okalhoma fields. Where it has been successful, the average increase of production has been 300%, and in some cases as great as 900%. It should, however, be stated that the average production of wells in the districts where the process has been used is less than one barrel per day.

Where the method is used, one producing well in a group is selected as an air-well. Best results are usually obtained when there is one air-well to three pumping wells. The air is forced down the air-well through a string of tubing with a packer at the end. It is important that the air does not have access to the stratum above the oil-sand. The pressure used is about 150 lb. per sq. in., varying somewhat with local conditions. From 5000 to 20,000 cu. ft. of free air per well per day is needed. The pumping-wells are operated as usual, either by jacks or on the beam.

The air takes up the volatile constituents of the oil in the form of vapor and is caught and used in the gas-engines required to operate the property. It is possible that this air might be used successfully for making casing-head gasoline. The first effect of the use of this process is an increase of gas from the

pumping-wells. Then follows an increase in water, and finally an increase in the oil production. Frequently the full effects on the oil production will not be seen for several months. There is also an increase in the amount of sand. The cost of installation is from $100 to $150 per well. There is also an increased cost of maintenance of from 25 to 50%. This process is sometimes used in connection with vacuum-pumps on the producing-wells, but since the limit of vacuum is about 10 lb., most operators prefer to carry more pressure on the air-compressors.

BLOWING WELLS

What are known as blowing wells are described by the United States Geological Survey, Department of the Interior, in a recent letter to a correspondent.

"Blowing" wells, also known as "breathing," "sucking," "weather," and "barometer" wells, it is stated, have been reported from many localities. When such wells have been carefully observed it has been found that the blowing and sucking occur alternately—that is, at certain times the blowing is outward and at intervening periods it is inward. It has been found that the phenomena are due to differences in atmospheric or barometric pressure. The necessary conditions seem to be a porous stratum, such as sandstone, gravel, or porous limestone, only partially saturated with water, overlain by some impervious substance such as shale or clay. While the atmospheric pressure is high the air enters the well and collects in the upper part of the porous stratum above the water level. While the barometric pressure is low the air is expelled with considerable force, producing what is known as "blowing." This blowing frequently occurs during storm periods or when the wind is in a certain direction or during certain periods of the day.

VOLATILITY OF CASING-HEAD GASOLINE

An important factor in the market is the so-called casing-head gasoline, which is extracted from natural gas by compression or scrubbing. It consists of hydro-carbons of low boiling points and when unmixed with other products is extremely volatile. This product must be stored and handled with care in order to avoid exaporation losses. Casing-head gasoline is rarely or never used "straight," being generally mixed with enough heavy naphtha to bring it to the proper specific gravity. The tendency to evaporate is incidentally reduced, but still remains greater than that of a straight refinery product of approximately the same specific gravity.

Blended casing-head gasoline is an important factor in present market conditions and is not necessarily inferior to "straight" refinery gasoline. Although the tendency to evaporate is great there is an advantage in the fact that blended gasolines undoubtedly "start" with great ease in an engine. In addition it is claimed, with what seems perfectly sound logic, that the hetrogeneous character of this gasoline slows down the velocity of combustion and results in maximum pressure being developed with a gradual push on the engine piston rather than with a sharp explosion. This results in the development of maximum power with a minimum of strain from high pressures. No data are at hand to support the claims generally made by producers of blended casing-head gasolines, but the contentions stated seem reasonable in theory.

It is possible by means of a distillation to distinguish blended casing-head gasoline from ordinary refinery products because the volatility range of the former has more or less definite general characteristics.—*Walter F. Rittman.*

THE ENGINEER SALESMAN

BY GEORGE P. BALDWIN

The first requisite for a successful sales transaction is a scientifically designed and well manufactured product. The next element is the salesman's intimate knowledge of this product and its application; and the third and most important feature as far as the commercial engineer is concerned is his ability to establish and maintain favorable relations with the people with whom he is brought into contact. It is this ability to establish favorable relations and maintain them that produces results and for which the engineer who desires to enter the commercial field must train himself. He must have not only sound engineering knowledge, but must also supplement this with a well-rounded-out knowledge of men, and affairs in general; this latter feature is important and, strange to say, is often lost sight of by the young man.

A man who is now a prominent executive in one of our engineering organizations nearly marred his career because of his neglect to realize this. The great turning point came when he was offered the position of Treasurer of his company. He hesitated. He considered it unfortunate. He feared he would no longer remain an engineer. Yet he finally yielded to exterior pressure and accepted the position. Later developments proved, without question, that this was the best step he could have made for it broadened his vision. Since he has crossed the threshold into the commercial world he has been able to make use of his engineering knowledge in a vast number of diverse fields. Today he is amazed at the ignorance which caused him to hesitate.

His successful career is an example of what can be done today in commercial engineering. The old school salesman has passed. The salesman of today must thoroughly know his subject. If he does not have a deep knowledge of engineering principles and their application as well, he may try to get business by means of guessed-at statements; or should he not yield to this temptation, he will find himself often in the position where he must confess his ignorance in the presence of the prospective customer and offer to send to the home office for an engineer. The doctrine of the survival of the fittest is rapidly eliminating this type. Today, the great manufacturers realize that the man to get the business should really be an engineer and be able to discuss intelligently the topics under consideration in all their phases. It has been proven that the old method was economic waste; the new method is modern business.—*General Electric Review.*

NEW BOOK

COMPRESSED AIR. THEORY AND COMPUTATIONS. By Elmo G. Harris. Second edition, revised and enlarged. McGraw-Hill Book Company, Inc., New York. 206 pages 6 by 9 inches, 32 cuts, numerous diagrams and elaborate tables. Price $2.00.

This excellent work has deservedly and properly attained its second edition. It is an ideal book for college use. For the student of compressed air theory and for the seeker of precision in practice it is indispensable. Errors and ambiguities of the first edition have been eliminated and valuable matter has been added. There is a new chapter on centrifugal fans and turbo compressors and an appendix on the designing of logarithmic-charts.

NEW PUBLICATIONS OF THE BUREAU OF MINES

Coal-mine fatalities in the United States, 1916, compiled by A. H. Fay. 1917. 42 pp.

BULLETINS

Bulletin 119. Analyses of coals purchased by the Government during the fiscal years 1908-1915, by G. S. Pope. 1916. 118 pp.

Bulletin 143. Abstracts of current decisions on mines and mining, reported from May to August, 1916, by J. W. Thompson. 1917. 72 pp.

TECHNICAL PAPERS

Technical Paper 87. Methods of testing natural gas for gasoline content, by G. A. Burrell and G. W. Jones. 1916. 26 pp., 7 figs.

Technical Paper 106. Asphyxiation from blast-furnace gas, by F. H. Willcox. 1916. 69 pp., 8 pls., 11 figs.

Technical Paper 165. Quarry accidents in the United States during the calendar year 1915, compiled by A. H. Fay. 1907. 77 pp., 1 pl.

Technical Paper 168. Metal-mine accidents in the United States during the calendar year 1915, compiled by A. H. Fay. 1917. 114 pp., 2 figs.

Note.—Only a limited supply of these publications is available for free distribution, and applicants are asked to cooperate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

POTASH

Some years ago the United States was content to believe, and even freely acknowledged, that Germany held a world-monopoly in potash, and consequently that our grains and grasses and the greater part of our most nutritious foods were dependent upon the rejuvenation of our soils by this precious alkali, which came exclusively from the mines at Stassfurt. We were also taught to believe

that the only possible rival of Stassfurt was the great salt deposit of Kalusz in the Carpathians. Recently the German technical staff has indulged in jubilant comment upon the crop-shortage in the United States for the season of 1916, attributing it directly to a scarcity of potash. As a matter of fact the diminished harvest last year, and the threatened deficiency in 1917, are the result of inclement weather-conditions in Western areas where fertilizers as yet have scarcely been applied to soils. Nevertheless there is an immediate scarcity of potash, and the price is correspondingly high, with a relatively inactive market. The increase in price from about $30 per ton for the chloride in normal times to $400, as now quoted, exerts a restraining influence on the agricultural demand as reflected through the manufacturers of fertilizers. The farmer is content to let the plants starve a little if necessary. It will be seen that, with such high prices for plant-foods, the farmers' investment in a growing crop is enormously increased, and the losses incident to unfavorable weather-conditions become increasingly great, introducing risks that might easily become ruinous. This situation deserves the serious consideration of the Government, and amid the host of other problems neither Congress nor the Departments of Agriculture and Commerce seem to have seriously grappled with the question.

An interesting fact, which should be made clear in order to create a correct public opinion upon this matter, is that we are not necessarily dependent on *Mittel Europa* for potash. Some of the cement-mills of America are making nearly as much money at this moment out of their by-product recovery of potash as they derive from the cement itself. Every cement works today is becoming a potash factory. The iron blast-furnaces are also preparing to enter the field. Not long ago Mr. R. J. Wysor of the Bethlehem Steel Company made an elaborate investigation into the possibilities of recovering larger quantities of potash than heretofore from the blast-furnace gases. He found that 20% of the original potash content remained in the gases after passing through the scrubber, and furthermore that the larger proportion of the total potash is dissolved and lost in the primary and secondary washers. An average furnace-charge at Bethlehem contains about 22 pounds of potash per ton of pig-iron produced, of which only 20% is carried off in the slag, leaving 80 % that may in part be recovered from the gases. Mr. Wysor states that the gases when passed through an experimental Cottrell electric dust-precipitator yielded practically all the potash in the collected precipitate. The saving effected by the same means at the cement factories ranges from 90 to 95% of the potash in the kiln-gases. It thus appears that in Pennsylvania alone, which produces normally ten million tons of pig-iron per annum, assuming a net recoverable 10 pounds of potash for each ton of pig-iron, 50,000 tons of potash might be made available yearly. Ohio would yield half as much on the same basis. In Alabama the outlook is still more remarkable. The so-called "gray ores" are exceptionally rich in potash, containing over 80 pounds of the alkali per ton of iron on the charge. The additions from coke-ash and flux bring up the total to nearly 100 pounds. Mr. Charles Catlett has estimated that a net recovery of 77 pounds of potash per ton of iron can be obtained in connection with the smelting of these ores. By the installation of the necessary equipment it is evident that the iron industry alone can supply over one-third of our normal demand for potash, obtainable at relatively insignificant cost as a by-product. The cement industry can do as much, so that our survival among the nations of the earth manifestly does not depend upon the favor of Germany. As a matter of fact we have not yet begun to realize upon these resources as we must. In 1916 the total output of by-product potash in the United States was only 8264 tons, with an additional 1550 tons derived from the treatment of kelp. The foregoing figures include molasses distillery waste, which contributed 1845 tons. It is not creditable to the energy and foresight of our people that we should have provided only 5% of our normal consumption of this vital necessary, when 60% at least is immediately available by the application of means that have been developed by Mr. Frederick G. Cottrell and his associates, and proved successful in operation.—*Mining Press.*

STELLITE

According to an account given in *Metaux et Alliages*, the hard non-ferrous alloy, stellite, invented three or four years ago in the United States by Elwood Haynes, marks a still greater

advance in the art of cutting metals than established by the notable results obtained with the introduction of high-speed steel some years earlier. Where rate of production is a critical matter, as in the manufacture of ammunition, it has already made a remarkable record in competition with high-speed steel, a material which in point of capacity of production outclassed steels previously used. One of the advantages of stellite is that its hardness, which it maintains even at a red heat, is solely dependent upon the composition of the alloy, tungsten and chromium with additions of cobalt and molybdenum, and not upon the difficult and uncertain operations of heat treatment. Its fundamental advantage, however, lies in its ability to withstand a marked increase in speeds and feeds over those previously used with high-speed steels.

NOTES

The U. S. Army, quartermaster department, has given out a statement to the effect that they would need, in order to move 80,000 men, one field army, 6229 cars, made up into 366 trains with as many locomotives. These 6229 cars would consist of 2,115 passenger, 385 baggage, 1055 box, 1899 stock and 775 flat cars.

More than 10,000 chemists, metallurgists and mining engineers have been enrolled by the Bureau of Mines in its mobilization of technical men willing to help in the war. The list being tabulated for the use of the council of national defense and the army and navy, includes several thousand in the making of iron and steel.

The subway system of the Interborough Rapid Transit Company, New York, N. Y., has carried 2,958,200,205 passengers, about twice the population of the world, in ten years. Each year it carries more than a third of the total number of passengers carried on all the railroads of the United States. Only one passenger has been killed in a subway train accident in ten years.

In a certain laundry decidedly objectionable conditions prevailed on account of the air currents generated by rapidly rotating pulleys which sucked in dust with air from the outside, allowing it to settle upon the clean linen and in various spots where it was not wanted. The trouble was cured by clamping disks of sheet meal upon each side of the pulley arms, thus killing the centrifugal action.

During the three months ending March 31, 1917, there were 83,652,907 lbs. of bleached cotton fiber, including linters and hull fiber, consumed in the United States in the manufacture of guncotton and explosives of all kinds.

Zinc sulphate is not only a preservative of wood, but also of leather and other organic matter. A practical use of it is to saturate the soles of shoes and boots with a moderately strong solution of the salt. Thus treated the sole-leather resists wear to an extraordinary degree. Fabrics saturated in zinc-sulphate solution and then dried are resistant to fire; that is, though they will char on being heated, they will not transmit the flame by becoming ignited.

"When public money is honestly spent on a road every dollar becomes three dollars," says the Portland (Ore.) Journal. "First, there is the dollar in the road itself. Second, there remains in the community the dollar which has been paid out for labor and material. Third, there is the dollar of economic value added to the land adjacent to the road. This is a real value, not a speculative one. It is an increase in productive capacity."

A recent "heat-neutralizing mixture for treating burns" is formed as follows, according to U. S. Pat. 1,204,830: A lard-like mass is formed of 13 lb. lime, 3.5 gal. water, 7.5 lb. black mineral oil, 2.5 lb. red oil, 2.5 lb. soda ash and 1 lb. yellow ochre. This sounds all right, but the description then adds, "The mixture may also be used as a lubricant on axle journals or other machine parts." As this concoction seems to be a sort of *vade mecum*, we nominate it also for salad dressing, hair oil and hog-cholera cure.—*Eng. and Mining Journal.*

The Aircraft Manufacturers' Association desires to get into communication with all manufacturers of finished products and producers of raw materials entering into the construction of aircraft of all descriptions. It desires among other things samples of steel tubing, leather, aluminum, turnbuckles, aviators' wire,

and catalogs of fittings, instruments and equipment of every sort. All communications, samples and data relating to the above materials should be addressed to the Aircraft Manufacturers' Association, 501 Fifth Avenue, New York.

Cordite has been discovered to possess the properties of a drug. It is said to have a sweetish taste and to produce temporary exhilaration with ultimate bad effect on the nervous system. Women munition workers in England, are said to have been detected chewing it.

The straw-hat trade of Luton and Dunstable, (England) and other places in the neighbourhood, depends upon the fact that the straw used for plaiting is grown on adjacent chalk land. The plant has great affinity for the silica in the chalk and flints, and uses it for coating the outside of the stalk with its beautiful glass-pipe covering. And it is due to this fact that America, although she grows such enormous quantities of wheat upon her alluvial lands—having no chalk land—has to send to England for straw, through which her people consume their iced drinks.

Work on the second Simplon Tunnel has been greatly impeded owing to war conditions. The work on the northern section was stopped in August, 1914, and was not recommenced until February, 1916, but work has been continued on the southern section with a reduced number of men. On July 31, a distance of 20,340 ft. of the northern section, and of 24,600 ft. of the southern had been tunnelled. At the present rate of progress it is calculated that the former section will be completed on December 31 next, and the latter on August 31, 1918.

Success in the Metallurgical use of powdered coal requires (1) that the coal have a high volatile content and a low percentage of ash; (2) that, after pulverizing, the moisture in the fuel shall not exceed 0.75 per cent.; (3) that the fuel shall be pulverized so that at least 95 per cent. will pass through a 100-mesh sieve and over 83 per cent. through a 200-mesh sieve; (4) that the delivery of the coal to the furnace shall be uniformly controlled regardless of the quantity required; (5) that the fuel be delivered to the furnace in a thoroughly atomized state and that combustion be completed while the coal is in suspension; (6) that in the application of the fuel to the furnace, the personal equation be eliminated as far as possible.—*C. J. Gadd, Journal of the Franklin Institute.*

A resourceful farmer has found a new way to use dynamite that saved a nearly matured crop of potatoes in a badly flooded field. Unusually heavy rains filled all the neighboring drains and ditches so there was no relief for the flooded field; and in this emergency the owner put down a number of holes eight to twelve feet deep with a post auger, and exploded a charge of dynamite in the bottom of each. This opened up passages into the sandy subsoil through which the surplus water drained rapidly, and the crop was saved, although many nearby crops were ruined by the excess of water standing in the fields.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 1

1,224,146. PUMP-UNLOADING DEVICE. Philip L. Crittenden, Edgewood, and Lawrence D. Saunders, Wilkinsburg, Pa.

1,224,180. APPARATUS FOR TREATING CERTAIN DISEASES OF THE HUMAN BODY. Simon Lake, Milford, Conn.

4. Therapeutic apparatus, comprising a substantially air-tight chamber, means associated with the chamber for creating a pressure therein above the normal atmospheric pressure surrounding the chamber, other means for reducing the pressure within the chamber below the normal surrounding atmospheric pressure, valves for maintaining a predetermined pressure within the chamber, a relief valve, and means for intermittenly operating the relief valve at regular intervals.

1,224,218. MEANS FOR PRODUCING AIR-CURRENTS. Harold M. Scheibe, Cambridge, Mass.

1,224,221. AUTOMATIC ATMOSPHERE VALVE. Harry Schwanebeck, Baltimore, Md.

1,224,238. BRAKE AND SAFETY CAR CONTROL. Walter V. Turner, Wilkinsburg, Pa.

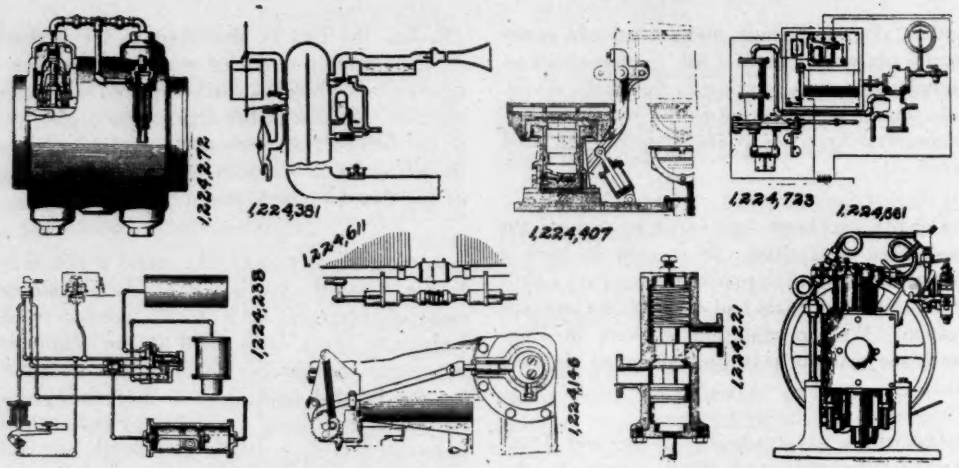
1,224,272. UNLOADER FOR AIR-COMPRESSORS. William H. Callan and George J. MacFadden, Franklin, Pa.

1,224,381. PUMP AND COMPRESSOR. Herbert Alfred Humphrey, London, and William Joseph Rusdell, Dudley, Worcester, England.

1,224,407. COMBINATION JOLT - RAMMING AND ROCK-OVER MACHINE. William C. Norcross, Terre Haute, Ind.

1,224,481-2. VACUUM CLEANING AND FORCE-DRAFT SYSTEM. Frank J. Matchette and Richard Raddatz, Milwaukee, Wis.

1,224,545. MEANS FOR DETERMINING GROUND SPEED. Lodewyk J. R. Holst, Philadelphia, Pa.



PNEUMATIC PATENTS MAY 1

1. Apparatus for determining the ground speed of air craft comprising in combination means, adjustable for different air craft elevations, for determining the beginning and end of the time interval required for an air craft to travel a predetermined distance over the earth's surface, and a timing mechanism graduated in units of ground speed for measuring the duration of said time interval.

1,224,611. AUTOMATIC COUPLING FOR AIR-PIPES. Harry Currier, Madison, Me.

1,224,661. MULTISTAGE COMPRESSOR. Nelson J. Parker, Lincoln, Ill.

1,224,723. TRAIN-STOPPING APPARATUS. Baltis Arthur Durham, Irvington, N. J.

MAY 8

1,224,914. GREASE-GUN. William T. Field and John A. Dumbolton, Lincoln, Nebr.

1,224,940. FLUID-PRESSURE-CONTROLLING APPARATUS FOR RAILWAY-VEHICLES. Lloyd V. Lewis, Edgewood borough, Pa.

1,225,211. APPARATUS FOR CONDITIONING AND DEHYDRATING FIBROUS AND OTHER BODIES. George Hillard Benjamin, New York, N. Y.

1,225,212. ART OF DRYING BODIES. George Hillard Benjamin, New York, N. Y.

1,225,269. BREATHING APPARATUS FOR USE IN NOXIOUS GASES. James W. Paul and Clarence Hall, Pittsburgh, Pa.

1,225,395. SPHYGMOMANOMETER. George F. Beachler, Cleveland, Ohio.

1,225,455. PNEUMATIC SHOE. Raffaele Marabini, New York, N. Y.

1,225,574. APPARATUS FOR CONDENSING GAS UNDER HIGH PRESSURE. Godfrey L. Cabot and James J. Cabot, Boston, Mass.

1,225,612. PERCUSSIVE TOOL. George James Gawley, Fleet, England.

1. An apparatus for utilizing atmospheric pressure for delivering impacts comprising a chamber having a closed end adapted to be placed against the article to be struck, the opposite end of said chamber being open to the atmosphere, a piston mounted in said chamber and adapted to be moved toward said closed end for delivering an impact thereto by atmospheric air entering said cylinder and means for moving said piston away from the closed end of the cylinder, whereby a vacuum will be created between the closed end of the cylinder and said piston.

1,225,684. AIR-MOISTENING DEVICE. Oliver I. Shaver, Park Rapids, Minn.

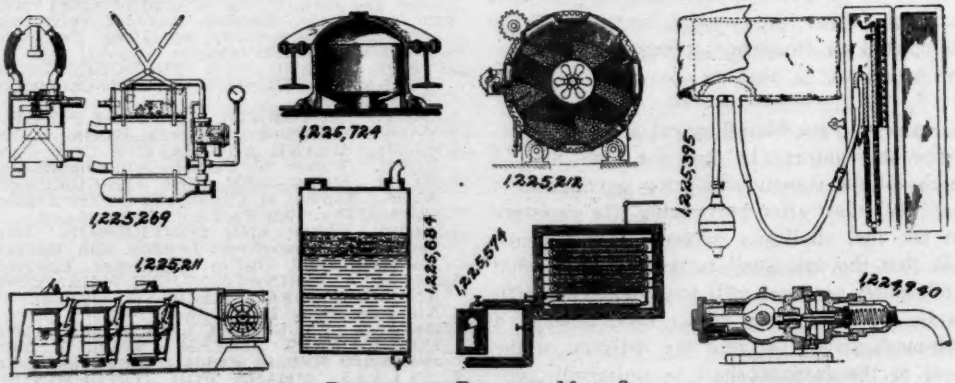
1,225,696. AIR-WASHING APPARATUS. Chas. H. Bicalky, Buffalo, N. Y.

1,225,709. PNEUMATIC ACTION FOR PNEUMATICALLY-OPERATED MUSICAL INSTRUMENTS. Adolph Peter Gustafson, Chicago, Ill.

1,225,724. VACUUM LIFTING-CUP. Carlton L. Smith, Saginaw, Mich.

MAY 15

1,225,805. AIR AND GAS COMPRESSOR. Augustus W. H. Griepe, New York, N. Y.



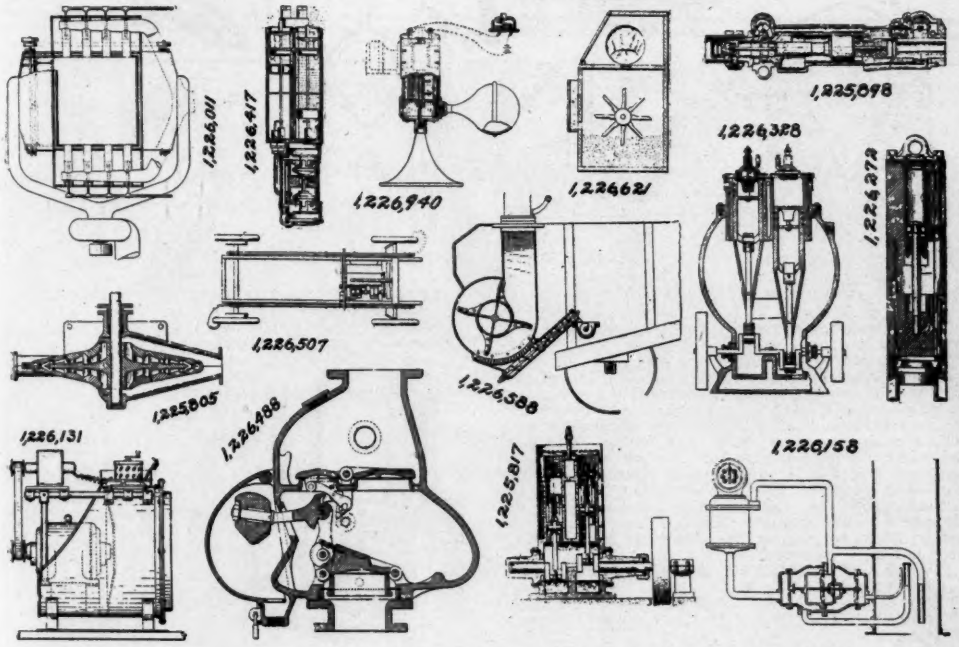
PNEUMATIC PATENTS MAY 8

1,225,817. COMPRESSOR. William H. Howe, Chicago, Ill.
1,225,898. ROCK-DRILL. Daniel Shaw Waugh, Denver, Colo.
1,225,902. PRESSURE - CONTROLLING MECHANISM FOR AUTOMATIC MUSICAL INSTRUMENTS. Edwin Welte, Freiburg, Germany.
1,225,940. ALARM DEVICE. Laurens P. Dixon, New York, N. Y.
1,226,011. DESICCATING APPARATUS. Chas. E. Rogers, Detroit, Mich.
1,226,131. BLOWER. Ira H. Spencer, West Hartford, Conn.
1,226,158. PROPORTIONAL GAS - METER. Thomas B. Wylie, Pittsburgh, Pa.
1,226,272. PILE-HAMMER. Thomas E. Sturtevant, Dover, N. J.

1,226,831. APPARATUS FOR TREATING COCOA AND OTHER PULVERULENT MATERIAL. John Walker, Boston, Mass.

1. An apparatus of the character specified comprising a centrifugal separator, a pipe of considerable extension and diameter coiled about said separator and connections therewith, and means for inducing a current of air with material therein to be treated to pass through said pipe and afterward develop a cyclonic action within said separator, said pipe and associated parts being adapted whereby as the air passes through said pipe the material therein may be subjected to attritive influence through contact with the wall of said pipe.

1,226,832. PNEUMATIC PITMAN - BALANCE FOR SWING-JAW ROCK AND ORE CRUSHERS. Fred M. Webber, Joplin, Mo.



PNEUMATIC PATENTS MAY 15

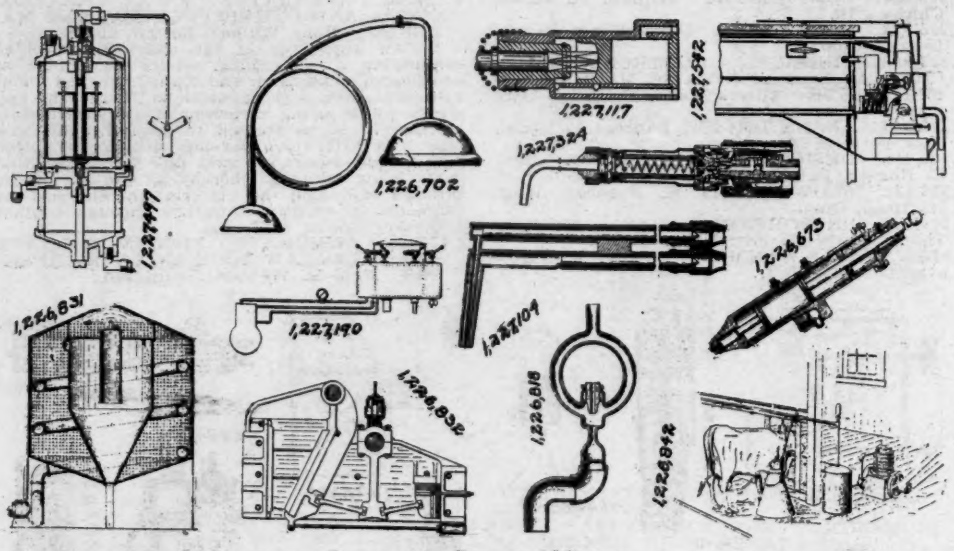
1,226,326. PNEUMATIC ACTION. Charles G. Gilberg, Rockford, Ill.
1,226,328. AIR-COMPRESSOR. Venable J. Guthrie, Cambria, Va.
1,226,408. DIE-CASTING MACHINE. Louis P. Tenca, Cleveland, Ohio.
1,226,417. FLUID-PRESSURE PUMP. Howard W. Truscott, Portland, Oreg.
1,226,488-9. DRY-PIPE VALVE. Powell Evans, Philadelphia, Pa.
1,226,507. TIRE - INFLATING APPARATUS. Learner E. Guess, Marion, Ky.
1,226,588. PNEUMATIC STRAW - STACKER. Victor N. Perry, Batavia, N. Y.
1,226,621. SAND-BLAST FOR SATIN-FINISHING METALS. Emil Gieland, Charlotte, N. C.

MAY 22

1,226,664. AIR-VALVE. Walter R. Hose, New Ulm, Minn.
1,226,673. PNEUMATIC CUSHIONING DEVICE. Peter W. Kane, Rochester, Wash.
1,226,702. VACUUM MASSAGE DEVICE. John G. Schlenter, Toledo, Ohio.
1,226,818. FLUID-PRESSURE SUCTION APPARATUS. John R. Schrader, New York, N. Y.
1,226,842. MILKING APPARATUS. Austin E. Anderson, East Randolph, N. Y.
1,227,104. BLOWPIPE. James Aslin, Providence, R. I.
1,227,117. PNEUMATICALLY - OPERATED PERCUSSION-TOOL. Heinrich Christiansen, Pinneberg, Germany.
1,227,190. HUMIDIFYING APPARATUS. Frederick W. Parks, Fitchburg, Mass.

1. In a humidifying apparatus, the combination with a tank having a central water-receiving compartment and a separate closed compartment encircling the water-receiving compartment, said water-receiving compartment extending above the closed compartment, means to maintain air under pressure in the closed compartment, a self-contained compressed-air actuated humidifying head mounted on top of and connected to the closed compartment, a water inlet pipe extending from said head into the water-receiving compartment, and means to maintain the water level in the water-receiving compartment at a point slightly below that of the humidifying head.

1,227,324. AIR-HEATER. Percy Russell, Brooklyn, N. Y., and Frank J. Sepas, Philadelphia, and Edward B. Wilford, Merion borough, Pa.



PNEUMATIC PATENTS MAY 22

1,227,497. VACUUM SYSTEM. William Scott, Medford, Mass.

1. A vacuum system for maintaining a substantially uniform head on flowing fluids, having, in combination, an intake chamber, an inlet passage thereto, a discharge passage therefrom, means for vacuumizing the chamber, a vacuum passage leading into the chamber through which it is vacuumized, an air passage connected with the atmosphere and with the intake chamber normally closed, means for closing the vacuum passage when a predetermined amount of fluid has been brought into the chamber, and means actuated by the vacuumizing means upon the closing of the vacuum passage for opening the air passage to permit the chamber to be under atmospheric pressure.

1,227,510. PNEUMATIC PLAYER MECHANISM. Frank C. White, Meriden, Conn.

1,227,542. MOISTURE-SUPPLYING DEVICE FOR INCUBATORS. Dave O. Lager, Helena, Mont.

1. The combination with a lamp and a lamp chimney, of means for humidifying the heated air passing about the chimney, including a drum surrounding and carried by the chimney, said drum having a lower inlet port and an upper outlet port, said ports being disposed upon opposite sides of the drum, a pipe connected to the outlet port and extending radially from the drum, a water receptacle attached to the drum, said drum being further provided with a port in its wall adjacent the connection of the pipe at the outlet opening thereof, and a wick carrying member insertible in said port and carrying a wick for disposition within the water receptacle.

MAY 29

1,227,564. ROCK-DRILLING ENGINE. Gustaf Anderson, Stockholm, Sweden.

1,227,715. COMPRESSED-AIR ENGINE. Aaron B. Webb, Streator, Ill.

1,227,762. AIR-PUMP. Harley M. Dunlap, Battle Creek, Mich.

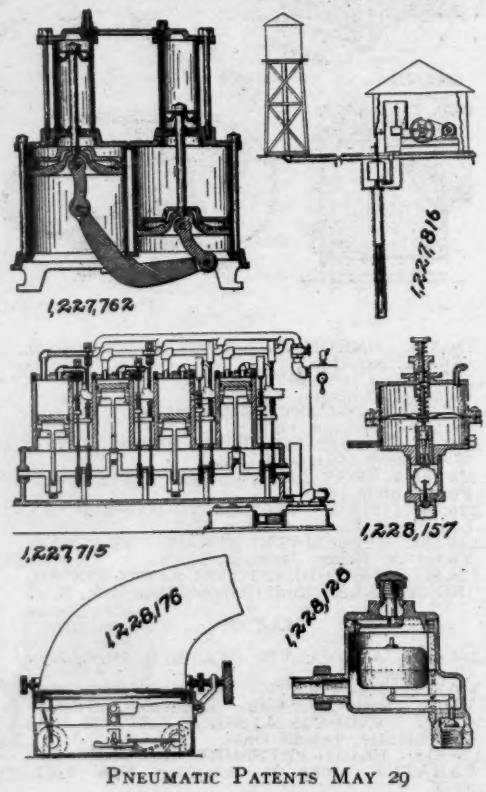
1,227,787. PNEUMATIC ACTION FOR PLAYER-PIANOS. Emory C. Hiscock, Chicago, Ill.

1,227,816. AIR-LIFT-PUMP BOOSTER. Frank S. Miller, deceased, Indianapolis, Ind., by Donold S. Morris, administrator *de bonis non*, Indianapolis, Ind.

1,228,128. VACUUM-TRAP. Andrew Olson, Chicago, Ill.

1,228,157. AIR-MOISTENER. William Wyand, Absecon, N. J.

1,228,176. VACUUM-CLEANER NOZZLE. Barry N. Bishop, Newark, N. J.



PNEUMATIC PATENTS MAY 29